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Insulation. AMONG the papers read at the Denver meeting of the Railway Telegraph Superintendents' Association was one by Mr. T. A. Edison, published in this issue, which is interesting reading to those who have to do with the insulation of telegraph lines. It is in the nature of a general summary of the subject, and contains some useful data and advice to telegraphists. Among other data he gives a table of the actual resistance of various insulators, which, if from a reliable source (which he unfortunately does not give) is quite valuable information. In this table oil of wood tar greatly exceeds all the others, being 13 times that of paraffine wax and 200 times that of heavy paraffine oil: next comes crude ozokerite, which is one-quarter as good; then stearic acid at about one-fifth that of oil of wood tar. He states that for running lines it is not so much the high resistance of the insulation which is of importance as it is the mechanical qualities of the insulator. The most perfect line insulators in existence, he says, are those using oil, which defy the weather and the fog; he adds that high insulation is not the greatest desideratum, as it tends to retard signaling by preventing the line from discharging itself as quickly.

Representation of Lines of Force. THE graphic representation of the magnetic field is a subject to which Prof. E. J. Houston has recently given considerable attention, and he has succeeded in producing some very excellent results. A number of specimen prints were obtained by the method described by Prof. Mayer in 1871. This process consists in sprinkling some iron filings over the waxed surface of a glass plate held in a magnetic field, and in fixing them in whatever position they may assume by slightly warming the wax and allowing it to cool again. This plate is then used for direct photographic printing on sensitized paper. After reinventing and using this process Prof. Houston hit upon another method of securing the same result which he considers much superior to that just described. He places a dry sensitized plate over the field which he wishes to study. After the characteristic groupings of filings have been obtained, the plate is exposed, while over the magnet, to a gas or other suitable light for a few seconds. The operation is necessarily performed in the dark photographic room. For this reason the operator is unable to see whether the filings have been properly sprinkled over the plate. It would seem to be a better way to arrange the filings upon a very thin glass plate of the ordinary kind placed at a little distance from the magnet poles. After darkening the room a sensitized plate could be passed under the one containing the filings and the figures fixed in the way Prof. Houston has described.

Disturbances of Voltmeter Readings. THE use of accurate electrical measuring instruments in the shop or factory almost invariably raises the question as to the influence of metallic tools which may be in proximity to the instruments. Some extended experiments to ascertain the amount of this influence in the case of the Weston voltmeter were recently made by Mr. J. A. Stewart, and the results have been embodied in a brief paper just presented before the Franklin Institute. It was found that an ordinary 12-inch file placed in different positions near the voltmeter produced practically no effect when every part of the file was at least four inches distant. When, however, the file was placed against the binding post side of the instrument in such a way as to touch the base throughout its length the deflection was changed over four per cent. An ordinary bench vise, under similar conditions, introduced about the same error in the instrument's indications. It was also found that two instruments placed one foot apart had practically no effect on each other's readings. If, however, they are placed against each other, so that the bases touch along the binding post ends, the disturbance may be as much as five per cent., while, on the other hand, neither instrument affects the reading of the other by as much as one-fourth of one per cent. if one is placed with its scale side against the second one in such a way that the pointers of the two instruments are at right angles. It would be interesting to know definitely what amount of disturbance is caused in these instruments by the proximity of large electromagnets, such as those of a dynamo, and we understand that the same experimenter is investigating this question.

Incandescent Lamp Curves. THE dividend-paying capacity of a central station whose business is largely composed of incandescent lighting depends so much upon the lamp and its satisfactory operation that the curves showing the inter-relation of voltage, currents, watts and watts per candle power which Professor Roberts gives in connection with his article in another column will doubtless be studied with considerable interest. These curves may well be studied in connection with those given in Professor Thomas' paper read at the Chicago meeting of the American Institute, but which has not yet been published. Professor Roberts rightly calls attention to the fact that it is of the utmost importance for the average station manager to consider that a lamp's life may be very materially shortened by a comparatively slight increase of voltage. It need scarcely be pointed out that the close margin often available for dividends can easily be wiped out by lack of attention to this one point in central station management. The second part of Prof. Roberts' article calls attention to a very ingenious method of calculating the size of wire for lamp circuits without the use of diagrams or tables. It is based upon the fact that the relation between the different numbers of the Brown & Sharpe wire gauge is a geometrical one, the factor connecting the weights and resistances of consecutive numbers being approximately 1.25. Although this fact has been well known to those who have had much to do with the comparison of different wire gauge standards, it is nevertheless true that it is not generally known by those who calculate the size of wire for lighting installations, and Prof. Roberts has done well to call attention to it once more, and to point out the use that may be made of it. The fact that the basis of the Brown & Sharpe wire gauge is a geometrical one received considerable publicity at the time of the exhaustive inquiry into this subject by the committee of the National Electric Light Association some years ago, and attention was also called to the same feature by Dr. S. S. Wheeler, in his article on "A Chart of Wire Gauges," in THE ELECTRICAL WORLD of Nov. 12, 1887. The possibility of calculating electric light wiring by means of this ratio is an admirable example of the value of a scientific basis for the standards of measurement that are used in every day engineering practice.

A Curve-Writing Voltmeter. EVERY one who takes an interest in the study of the internal performance of the dynamo will read with interest the description which we are able to give in another column of an exceedingly ingenious little instrument devised by Prof. Moler for recording the curve of potential distribution around the commutator of a dynamo. Prof. Moler is able to obtain, with about the same rapidity that one can take an indicator card from a steam engine, a curve that will tell to an intelligent electrical engineer a number of important features about the internal performance of the machine from which the curve is taken. It will show for instance at what points on the commutator the brushes should be placed to get the best results; but of much more importance is the information which it gives as to the relative idleness or activity of the armature coils as they pass through the different parts of the field and as to the actual intensity of the field in the various parts of the coil's path through a complete revolution of the armature. The use of this curve for this purpose is, of course, by no means new, as it was used by Prof. Thomas as early as 1880, and several modifications have been devised by S. P. Thompson, Mordey, Swinburne and others. Some interesting curves of this kind are to be found in recent papers read before the American Institute by Prof. H. J. Ryan and Mr. M. E. Thompson. But Prof. Moler's method of obtaining the curve, as one takes an indicator card, is a decidedly ingenious improvement over former methods. The feature of the instrument that will strike most readers as its chief defect is its failure to give ordinates of greater length. Unfortunately Prof. Moler has given no dimensions of his instrument, so that we are not able to judge of the possibility of improving it in this respect. The curves which Prof. Moler gives are fairly regular in their outline, and agree remarkably well with those obtained by other means. It would be interesting to know, however, if the agreement would be as close in the case of a curve of irregular shape, such as one taken from an open coil machine, or such an one, for instance, as would be obtained from a machine of obviously faulty construction. This curve, which might well be called the "induction," or "potential" characteristic, is rightly regarded as an important means of studying some of the principal features of a dynamo's design, and certainly deserves to be included in that general class of curves to which Marcel Deprez, in 1881, gave the appropriate and expressive name of characteristics.

The Efficiency of the Lauffen-Frankfort Transmission. AT last, after what appears to us an inexcusably long time, the results of the official measurements of the power transmission from Lauffen to Frankfort, by the three-phase alternating current, have been given to the public. These tests were made as early as October of last year, and it seems strange that it should have taken about seven months to calculate the results. A few bright American students could doubtless have made the calculations in a couple of days at the most. The results, published in another column, are a most excellent showing, and cannot help convincing the most skeptical. The maximum efficiency of 74 and 75 per cent. from the turbine shaft to the lamps, 110 miles distant, through three No. 6 wires, is certainly excellent, and as the results are vouched for by Prof. H. F. Weber, of Zurich, they can be relied upon as correct. It will be remembered by those who followed the description published in our columns last year that the line was smaller than it was intended to be, owing to the fact that it was a gratuitous loan. The curves accompanying our article show the effect of this small size very decidedly. If the line had been proportioned to suit the plant, the efficiency would have been still better for the larger loads. Another feature in its favor is that the dynamo and transformer, being both built for a greater output, would have had a greater efficiency if they had been run at full load. They were built for 200 kilowatts, or 270 metric h. p., while the largest load in the tests was less than 200 h. p. With the line properly proportioned to suit the rest of the plant, the efficiency would have been higher than 75 per cent., and would not have lowered for larger outputs, as it did in this case. It is, furthermore, not stated in the report what the voltage was, but from a very good authority who was present at the tests it appears to have been about 16,000 volts. This also is below what was originally intended to be used, namely 25,000. With this higher potential, the line losses, which are of course by far the greatest of all the losses, would have been considerably reduced, thus increasing the efficiency still more. Under the conditions for which the plant was originally built, the results would have been astonishingly good, but even under the adverse circumstances they are excellent, and should convince even the most skeptical. It is to be regretted that more data was not given for the benefit of engineers, showing the results at very small loads, the current and loss in charging the line, the frequency, etc., but this will doubtless all be forthcoming in the promised detailed report, which we fear, however, will be a long time coming. It can be seen from the curves and figures that the loss in induction and capacity, which some persons predicted would be so great as to make such a transmission prohibitory, are by no means very great. The shape of the curves will show some points regarding this question. As will readily be understood by engineers, the curves worked out by the author of the article show more than the mere figures published by the commission. It may be of interest to note here that as early as our issue of Sept. 5 we published a cable dispatch from private sources stating that the preliminary tests showed an efficiency of about 75 per cent.; this is now shown to have been remarkably close to the real value. In our issue of Jan. 9 we again published another estimate from a private and very reliable and conservative source that the efficiency was probably about 77 per cent.; as will be seen now, this was very nearly correct, being still several per cent. on the safe side. Those of our readers who are interested in this plant will find detailed and full descriptions in our issues of September and October of last year.

Denver Meeting of the Railway Telegraph Superintendents' Association.

The eleventh annual meeting was held at the Hotel Albany, Denver, Colo., June 15 and 16, in compliance with the instructions of the Cincinnati meeting last year. Mr. A. R. Swift, superintendent of telegraph of the C., R. I. & P. R. R., had made all arrangements for transportation from Chicago to Denver, as outlined by General Manager St. John in his letter extending the courtesies of the Rock Rock Island route to the association. Two Pullman cars were provided and the party left Chicago at 6 P. M., June 12, arriving at Denver Tuesday morning, June 14. The first session was called to order at 10:30 A. M., June 15, by President C. S. Jones. The following new members were elected: G. R. Stanton, F. H. Benjamin, C. S. Rhodes, L. S. Wells, J. S. Evans, G. B. McCoy, W. W. Ryder, E. E. Rittenhouse, D. C. Matheson and J. H. Crawford. The following honorary members were elected: Messsrs. J. J. Dickey, D. J. Higgins, Ralph W. Pope, Thos. D. Lockwood, T. R. Taltavall, T. A. Edison and Prof. W. F. Gardner. The following officers were elected to serve for the ensuing year: President, L. H. Korty, Omaha, Neb.; Vice-President, U. J. Fry, Milwaukee, Wis.; Secretary and Treasurer, P. W. Drew, Chicago, Ill. It was voted that the next meeting be at Milwaukee, June 20, 1893.

Mr. S. S. Bogart read a paper on batteries in which he called attention to the adaptability of the Edison-Lalande battery for electric railway signal work. Its internal resistance was but one-tenth of an ohm, it was perfectly constant, would not sulphate and was not affected by low temperature. He believed the time had arrived when they should discard the sulphate of copper battery. He was using it for block signals in preference to all others. He used four cells in series in closed circuit with a resistance of 10 ohms. There is tapped out of it a sounder, alarm bell and annunciator, the last two on the same cell.

At the close of Mr. Bogart's paper the meeting was visited by Governor Routt, of Colorado, who delivered an address of welcome to which President Jones responded.

The afternoon session on Tuesday was called to order at 2:45 P. M. The first paper read was that by Mr. Edison on "Insulation,"* followed by one by Mr. W. A. Gardner on "Time Signals."† Mr. Lockwood then gave a blackboard talk on "The Galvanometer and Its Uses," which was devoted to a popular explanation of the handling of that instrument, especially for telegraph work.

At the opening of the morning session on Wednesday Mr. Charles Selden read a paper upon "Electricity in Its Relation to Transportation,"‡ followed by a paper by Mr. J. B. Stewart on "Block Signals."§

At the afternoon session on Wednesday the following committees were appointed: Messrs. Selden, Greene and Gemmell, to revise the constitution; Messrs. Swift, Ford and Sholes, to prepare a new form of service card; Messrs. Reed, Fry and Ford, on arrangements for the next meeting; Messrs. J. B. Stewart, Gemmell and Adams, on topics, and Messrs. Selden, Leonard and Darlton on acknowledgment for courtesies extended the association.

The formal business of the meeting being finished, ex-President Jones called President Korty to the chair, and, in transferring the gavel, said that he desired to express his satisfaction at the most splendid success they had achieved at this meeting, which was of course due to the large attendance of members and their enthusiasm. President Korty, in reply, said that he was deeply sensible of his inability to fill the position thus vacated, but would do his best. The meeting then adjourned to June 20, 1893.

The following is a list of the members and guests in attendance at the meeting, most of whom were accompanied by ladies.

C. S. Jones, Ill. Central, Chicago; A. R. Swift, C., R. I. & P. R. R., Chicago; C. Selden, B. & O. R. R., Baltimore; O. C. Greene, No. Pac. R. R., St. Paul; C. M. Dugan, Ill. Central R. R., Jackson, Tenn.; P. W. Drew, Wis. Central R. R., Chicago; H. Magiff, Central Vt., St. Albans, Vt.; H. C. Hope, C., St. P., M. & O., St. Paul; G. L. Lang, N. Y. & N. E. R. R., Boston; M. B. Leonard, Ches. & Ohio R. R., Richmond, Va.; C. A. Darlton, R. & D. R. R., Atlanta, Ga.; J. L. Orbison, C., H. & D., Cincinnati, O.; J. C. Ford, C., St. P. & K. C., St. Paul; G. R. Kimball, B. & O., Newark, O.; G. T. Williams, N. Y. C. & St. L., Cleveland, O.; L. B. Foley, D., L. & W., New York; J. T. Gibbons, D., L. & W., New York; K. McKenzie, M. O., Jackson, Tenn.; H. C. Reed, M., L. S. & W., Milwaukee; J. B. Stewart, West Shore, New York; W. W. Jackson, N. Y. & N. E. R. R., Providence, R. I.; R. J. M. Danley, C., H. & S., Columbus, O.; W. B. Ward, B., C. R. & N., Cedar Rapids, Ia.; W. D. Vincent, B. & O., Pittsburgh; S. K. Bullard, M., K. & T., Sedalia, Mo.; U. J. Fry, C. M. & St. P., Milwaukee, Wis.; W. J. Holton, C. & W. I., Chicago; D H. Caldwell, N. Y. C. & St. L., Fort Wayne; G. C. Kinsman, Wabash R. R., Decatur, Ill.; H. C. Sprague, K. C., Ft. S. & M., Kansas City; L. H. Korty, U. P. R. R., Omaha, Neb.; C. G. Sholes, A., T. & S. F. R. R., Topeka, Kan.; A. R. Lingafelt, C., R. I. & P. R. R., Topeka, Kan.; W. P. McFarlane, F. E. & M. V, Omaha, Neb.; C. S. Rhoads, C., C., C. & St. L., Indianapolis, Ind.; F. M. Duncan, D. & R. G., Denver, Col.; W. W. Ryder, C., B. & Q. R. R., Chicago; Geo. B. McCoy, Ill. Central, Memphis, Tenn.; J. J. Dickey, Supt. W. U. Tel. Co., Omaha, Neb.; R. B. Gemmell, A., T. & S. F., Topeka, Kan.; E. R. Adams, P. & R., Reading, Pa.; J. J. Burns, D. & R. G., Pueblo, Colo.; E. W. Hammond, Missouri Pacific, St. Louis, Mo.; E. E. Rittenhouse, Colo. Midland, Pueblo, Colo.; J. W. Lattig, Easton, Pa.; S. S. Bogart, New York; W. S Logue, New York; H. F. Houghton, Decatur, Ill.; J. B. Shaw, Jamestown, N. Y.; Ralph W. Pope, New York; T. B. Lockwood, Boston; T. J. Smith, New York; H. R. Wilson, Chicago, Ill.; D. C. Matheson, Flint, Mich.; T. R. Taltavall, New York; G. W. Crook, Valparaiso, Ind.; A. P. Willoughby, Chicago; C. P. Mackie, New York; W. C. Gilhan, Kansas City.

* See p. 11 of this issue.
† See p. 12 of this issue.
‡ See THE ELECTRICAL WORLD, June 25, p. 438.
§ See p. 12 of this issue.

It was expected, when Denver was selected for the holding of the eleventh meeting, that the social features of the occasion would be unusually conspicuous. The various railroad companies centering in Denver vied with each other in offering the members every opportunity to view the natural wonders of Colorado, as well as the engineering skill which has enabled man to triumph over natural obstacles. Lack of time prevented the acceptance of but a small proportion of these courtesies. Friday was devoted to a trip over the Clear Creek division of the Union Pacific Railroad, which embraces the famous Georgetown loop. The Mendota silver mine was also visited. Saturday the members were the guests of the Denver & Rio Grande Company and the Manitou & Pike's Peak Railroad, and were taken over this famous cog-wheel line. Upon their return the Colorado Midland Railway Company ran a special through Ute Pass and return for their entertainment, and on Sunday the Denver & Rio Grande gave them a trip through the Royal Gorge to the Hanging Bridge. One of the most interesting events at Denver was the presentation of a solid silver salad bowl, fork and spoon to Mr. and Mrs. Swift, in remembrance of the thoughtful preparations for the trip and their watchful attention to all who had the pleasure of enjoying the many courtesies extended to the Association during its visit to the Centennial State.

Distance did not interfere with the enterprising exhibitors, who in their efforts to show the merits of their various exhibits added much to the interest and importance of the meeting.

The Leonard train order signal and the Leonard block signal were exhibited by the Electric Secret Service Company. Working models of these signals were shown in combination with the automatic selective apparatus of the Electric Secret Service Company. Other applications of the latter were shown adapted for telegraph, electric light and power service.

A working set of the Edison phonoplex was shown in actual operation, being connected with the line to Cañon City. Current was supplied by the Edison-Lalande battery, various sizes and forms of which were also on exhibition.

The Dulaney self-winding clock operated by two cells of gravity battery attracted much attention, it being in practical use on the Chicago, Burlington & Quincy Railroad.

The Gill-Alexander Electric Mfg. Company was represented by M. C. Gillham, who had arranged a working exhibit of the system of selective apparatus manufactured by that company.

The Iron Gravity Battery manufactured by the Standard Battery Company, 324 Dearborn street, Chicago, was shown by Dr. A. P. Willoughhy. In this battery an iron electrode is substituted for the zinc, as ordinarily used; a secret compound is used in the solution. The battery is now being tested by various companies.

The "Excessive Current Protector" invented by I. N. Miller, of Columbus, Ohio, was on exhibition, and explained by Mr. Leonard.

Samples of insulating fibre were shown by the Laminar Fibre Goods Company, of Boston.

Ampere-Centimetre, a Measure of Electro-Magnetism.

In commenting on an article on this subject published in our issue of May 28, 1892, *The Electrician*, London, states:

"The number of lines of force produced by a current C in any circuit is equal to the product $L\,C$, where L is the coefficient of self-induction of the circuit. L is a quantity whose dimensions are those of a length, so that Mr. Hering's first contention is quite justifiable; but in order that the number of lines produced may be proportional to the current multiplied by the length, it is evidently necessary that the self-induction of a circuit of given length must be the same however the wire is wound, and this cannot be even roughly true in the general case. With certain restrictions, it is quite possible that the proportionality holds; and when these conditions are fulfilled, the simple rule, that the flux of lines produced is proportional to the magnetizing current multiplied by the length of wire conveying it, becomes a useful working formula.

"On investigation we find that the following conditions are necessary in order that the number of lines of force in a magnetic circuit may be proportional to the number of ampère feet of magnetizing wire. The magnetic circuit must be very good, as in a dynamo machine in which little magnetic leakage occurs, and if the number of lines per ampère foot is to be the same for different dynamos, the iron must be of the same quality and magnetized to the same state of saturation, so as to have the same permeability, and the dynamos must be of the same type, that is, the ratio of the length of the magnetic circuit to its diameter must be constant. It is fortunate that these conditions are all very nearly fulfilled in the manufacture of any given type of machine.

"The following argument shows that Mr. Hering's contention is only true when certain conditions are fulfilled. Let A be the current in ampères flowing through a magnetizing coil of n convolutions. Let B be the density of the lines of force in the core whose permeability is μ. Let the length of the magnetic circuit (supposed closed) be l. Then

$$\frac{4\,\pi\,n\,A}{10} = \frac{B}{\mu}\,l.$$

The total number of lines flowing through the iron core is N where

$$N = B \times \pi\,r^2,$$

r being the radius of the iron core. If L is the length of the magnetizing coil,

$$L = n \times 2\,\pi\,r.$$

From these equations we find

$$N = \frac{\pi\,r^2\,\mu}{l}\,\frac{4\,\pi\,n\,A}{10} = L\,A \times \frac{2\,\pi\,r}{10\,l}\,\mu,$$

so that N will only be proportional to $L\,A$ (the number of ampères $\times$ by the length of the magnetizing coil), provided

$$\frac{r}{l}\,\mu$$

is constant.

"Mr. Hering's statement is, therefore, only true for closed magnetic circuits whose dimensions bear a constant proportion to one another, and the iron of which is magnetized to the same state of saturation, so as to have constant permeability."

The Chicago & St. Louis Electric Railway.

BY R. M. HUNTER.*

In THE ELECTRICAL WORLD of June 11 two pages are given to the above subject from the pen of Dr. Wellington Adams. Mr. Adams speaks as if the features of the railway were new and of his devising. In justice to the Thomson-Houston Electric Company, the General Electric Company and the Electric Car Company of America, I would make a few remarks which will more clearly show that these companies are entitled to the credit of the improvements proposed in the said railway. On pages 4 and 5 of the *Electrical Era*, published in Philadelphia on May 1, 1884, appeared an article on the electric railway written by me. The closing paragraphs read as follows:

> The foregoing brief statements as to the progress of the application of electricity to the propulsion of cars will show that despite the slowness of the public to aid its progress, it is bound in time to master the situation. It is unquestionably possible at the present time to erect an electric railway for passenger and mail traffic between Philadelphia and New York which would not only greatly reduce the time required to travel between these two great centres, but which would reduce the cost of fares to one-half the present value. All that it requires is energy, and sufficient capital. A single generating station located at Trenton is all that would be required for the eighty-five mile run when the road is constructed in accordance with the electrical laws.
>
> The future of the electric railway is good, and now that its progress is becoming rapid, the time will shortly be here when the electric railway will be accepted by the public as a reality, and one of the greatest boons to civilization.

It will be seen that a long distance electric railway was proposed by me between Philadelphia and New York, with but one generating station, long before Dr. Adams thought of it. As early as May, 1883, I had proposed such railways in England, one of which was to be between Calais and Dover, in a tunnel. In THE ELECTRICAL WORLD of June 16, 1883, appears a reference to my work. As my inventions and patents in electric railways are owned by the companies above specified, the credit of long distance lines belongs to them.

Now, to show that each and every feature of Dr. Adams' road is nothing but an embodiment of my inventions patented and owned by these well known companies, I will refer to the several features separately.

1. The roadbed having a central line of poles with cross-arms between two tracks and suspended positive working conductors from the arms is fully disclosed and claimed in my patents Nos. 438,847 of 1890, 450,074 of 1891, and 459,815 of 1891.

2. The supply or feeder conductors with such a construction as above are described and claimed in my patents Nos. 459,815 of 1891, 445,952 of 1891, 440,595 of 1890, and 450,074.

3. The employment of a railway using the suspended conductor with an under-running contact, and rails as return, is described and claimed in several of my patents among others I would say Nos. 598,402 of 1889, 448,618 of 1891, 426,382 of 1890, 432,752 of 1890, 438,847 of 1890 439,662 of 1890, 440,595 of 1890, etc.

4. The method of obtaining a straight working conductor by suspending it at intervals from a cable hanging as a catenary is described and claimed in my patents Nos. 446,833 of 1891, and 459,815 of 1891.

5. The location of the collector on a level with the roof of the car, and making an under-running contact, is disclosed and claimed in my patents Nos. 426,382 of 1890 and 432,752 of 1890.

6. The car having side entrances and close to the rails, while the motor trucks are at the ends, is fully described and claimed in my patent No. 385,053 of 1888. This was the kind of car I designed for the rapid transit Metropolitan Underground Railway in 1886, but it was invented by me some years before.

7. The electric brake for the cars is described and claimed in my patent No. 382,876 of 1888.

8. The arrangement of the motor on the axles independently of the car body, and having the axles inclosed in a frame upon which the car body rests by springs, is described and claimed in my patents Nos. 431,720 of 1890 and 385,053 of 1888. These are only two of a number of patents on this feature.

9. The employment of the alternating system with the step up and step down transformer system was fully devised by me in 1881, and is covered in my patent No. 460,071 of 1891, and is additionally covered in other pending applications. In this connection I enclose you a photo-lithograph of one of

my 1881 drawings on this system which will show the sections, trolley system and single and double conversion. The multiphase system is new, but that is not the invention of Dr. Adams.

10. A series of sections of a railway having separate generators and all controlled from one place is disclosed and claimed in my patent No. 448,523 of 1891.

11. Separate feeding circuits from one main generator to distant parts or sections of the same railway is disclosed and claimed in my patent No. 445,952 of 1891.

Aside from these patents these companies own a vast number which disclose and cover almost every minute detail of this Chicago and St. Louis electric railway. It is but fair that credit should be given to whom it belongs.

PHILADELPHIA, June 11, 1892.

The Silvey Electric Headlight.

BY W. L. SMITH.

It is very seldom that an invention comes perfect from the hands of an inventor without long, careful thought, numerous trials and repeated changes. Such is the electric locomotive headlight, invented by W. L. Silvey, of Lima, now of Dayton, O. As early as 1882 Mr. Silvey saw the necessity for a thoroughly reliable arc lamp for locomotives, and in the year 1884 brought out his first lamp and placed it on a number of steamboats on the Ohio River to be used as a search light in connection with the Silvey multipolar dynamo, manufactured by the Queen City Company.

This lamp was constructed somewhat like a tripod arc lamp having the positive and negative carbons fed together by gravity, the descent of the top carbon being so arranged that the lower carbon was drawn up half as fast as the top carbon was consumed, thereby maintaining the arc in the focus of the reflector. This was accomplished by a system of rollers around which strips of thin copper were wound differentially, the unwinding of the strip to which the positive carbon was attached would roll up the strip to which the lower carbon was attached, causing them to approach each other. The feeding was controlled by a friction clutch brake operated by a differential magnet. This lamp operated admirably on a steamboat, but when put to the severe test of a locomotive would not maintain a proper arc, the carbons jarring together, and it was therefore abandoned.

The next step was the Silvey mercury feed lamp—a decided step in the right direction—employing a metal point as a negative electrode. In this lamp a hollow iron column about 20 inches high was provided, with a loose fitting tubular piston having its lower end closed, a flexible tube connecting the lower end of the two tubes. Mercury was now poured into the outer tube in sufficient quantity to float the inner tube to the proper height, to which the positive carbon was attached by an overhanging arm. A needle valve was included in the flexible tube, which connected the inner and outer columns, the valve being controlled by an electromagnet whose coils were in derived circuit around the arc. As soon as the circuit was closed, the current in the derived circuit opened the needle valve, and allowed mercury to flow into the inner tube until the arc was established, at which time the valve was automatically closed by a reaction spring. The strength of the magnet and the spring were so proportioned as to allow the mercury to flow as fast as the positive carbon was consumed. The metal negative electrode was supported by the magnetic core of an arc-forming magnet. This lamp would stand almost any amount of hard usage, its only defect being that the column of mercury as it descended in height in the tube required a greater variation in the valve than was thought necessary, and it was determined to substitute a device entirely mechanical.

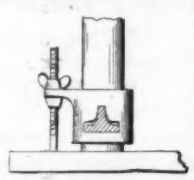


FIG. 1.—DETAIL OF MECHANISM.

With this object in view, Mr. Silvey devised a lamp in which the upper and lower carbons were fed together simultaneously by a differential right and left hand screw, the screw threads being so proportioned that the carbons would be fed at the proper rate as burned away. The feeding mechanism consisted of an iron feed lever, centrally pivoted on the screw rod and operating a ratchet wheel having 300 teeth. The motion of this lever was controlled by a vibratory motor of the simplest type, having a circuit breaker, the coils of the motor being in derived circuit to the arc, a shunt-wound dynamo of about 50 volts and 15 ampères being required to properly operate the lamp, the dynamo being driven by a small engine controlled by the engineer.

It was while experimenting with this device that the thought occurred to Mr. Silvey of using a secondary battery as a source of current, owing to the great amount of attention required by a dynamo and engine, their great liability to break down at any moment under the extreme speed and rough handling, together with their great first cost and maintenance. A number of different makers' secondary batteries were procured and tried, but they were all found too frail to stand the hard usage of locomotive service, and had to be abandoned.

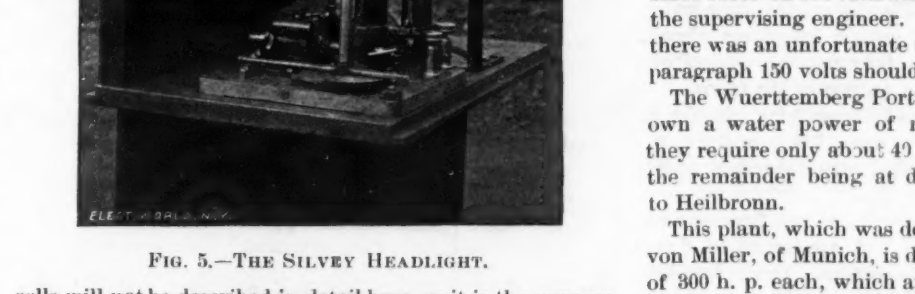


FIG. 6.—DIAGRAM OF CONNECTIONS.

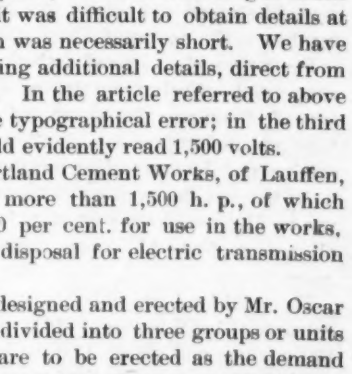


FIG. 7.—PLAN VIEW.

He now turned his attention to the secondary battery as an inventor, and having made a radical change in the construction of batteries adapted them to use, and they have never ceased to operate successfully from that time on. Several thousand Silvey secondary batteries are now in use on railroads extending over a period of about three years, and it is a notable fact that the buckling of the plates is a thing unknown, they have never been known to lose their active material, and in no single case was ever a cell short circuited between the plates from any cause. These

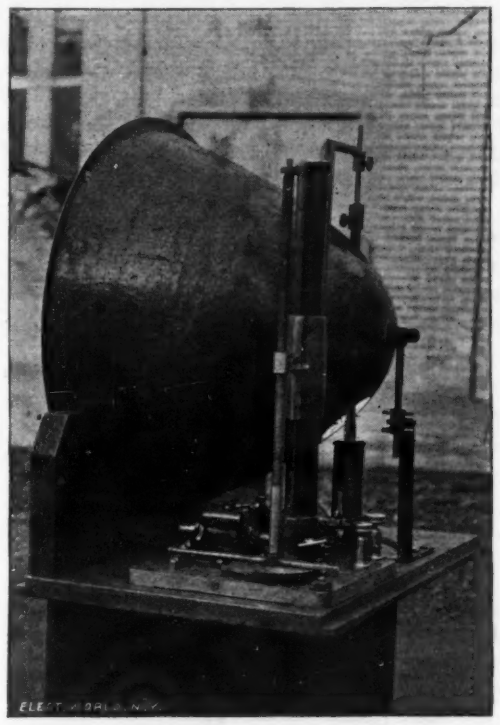


FIG. 5.—THE SILVEY HEADLIGHT.

cells will not be described in detail here, as it is the purpose of this article to describe the headlight proper.

The lamp as now built and which has been in practical operation for about two years is fully illustrated in the accompanying cuts. It will be seen to consist of an upright column fastened to a flat base plate. Traveling up and down on this column is a sleeve to which a forwardly projecting arm is fastened, and at the back of the sleeve a tail piece through which a vertical screw passes. This screw has a ratchet wheel secured to its lower end and a centrally pivoted ratcheted lever. On the base of the lamp is a small series wound motor connected in derived circuit around the arc, through the coils of which about one per cent of the current passes. On the motor shaft is an eccentric cam operating an eccentric lever, one end of which is connected with the ratchet lever and whereby the rotary motion of the armature imparts a to-and-fro motion to the ratchet, thereby turning the feed screw by a step by step motion, feeding the positive carbon downward until it has come in contact with the negative electrode, at which time the motor ceases to operate until the resistance of the arc requires the carbon to be fed. The pitch of the feed screw and that of the ratchet wheel are so arranged that nearly 5,000 revolutions of the motor are required to feed the carbon through a space of one inch, hence it is very seldom that the motor is entirely stopped, since it will feed the carbon as fast as required, the usual rate of operation being about 60 revolutions per minute; but in case of open circuit at the arc the speed may increase suddenly to as much as 3,000 revolutions per minute until the contact is made, at which time the motor instantly stops. A suitable rheostat is included in the circuit situated directly over the head of the engineer in the cab, who can control his light from a faint glimmer of a few candle power up to 5,000 c. p., or he may extinguish it entirely on sidings.

A view is shown of an express engine on the D. & M. R. R., equipped with the light, the battery of 24 cells of 150 ampère hours each, located in a box on the tender, entirely out of the way. An examination of the diagrams will show that the cells are charged without removing them from the engine, each stall at the roundhouse being provided with flexible plugs, so that as soon as an engine is run in the current is connected to the battery from a shunt wound Silvey dynamo of about 65 volts and 700 ampère pressure, and when the engine is ready to go out again the batteries are charged. This light having now been commercially before the railway public for about two years, has proved itself amply able to meet all requirements; and although it has never been described before, it has been purposely withheld from publication until its merits were fully determined by long practice and the most severe tests to which it could be put in regular service, extending over long periods of time, during which it has proved itself to be a thoroughly reliable electric locomotive headlight.

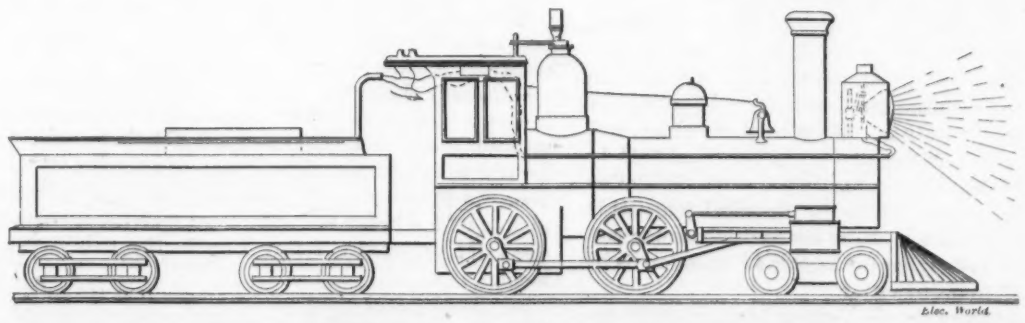


FIG. 2.—GENERAL ARRANGEMENT OF APPARATUS.

FIG. 3.

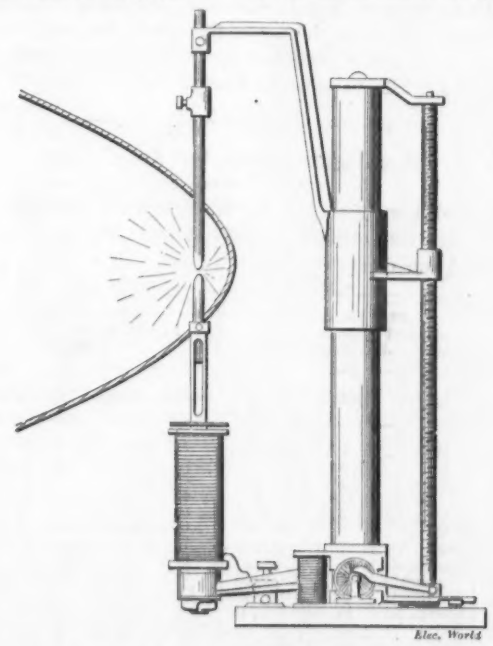


FIG. 4.—DIAGRAM OF LAMP.

The Three-Phase Alternating Current Plant at Heilbronn, Germany.

In our issue of April 23, page 276, we published a short description of this pioneer plant, which is attracting so much attention abroad, but as it was difficult to obtain details at that time our description was necessarily short. We have since received the following additional details, direct from the supervising engineer. In the article referred to above there was an unfortunate typographical error; in the third paragraph 150 volts should evidently read 1,500 volts.

The Wuerttemberg Portland Cement Works, of Lauffen, own a water power of more than 1,500 h. p., of which they require only about 40 per cent. for use in the works, the remainder being at disposal for electric transmission to Heilbronn.

This plant, which was designed and erected by Mr. Oscar von Miller, of Munich, is divided into three groups or units of 300 h. p. each, which are to be erected as the demand increases. Up to the present time there are installed two turbines, each driving a 300 h. p. dynamo, of which one is held in reserve at present. The turbines make 35 revolutions, and by means of bevel gearing drive a three-phase generator, designed by Mr. Brown, and manufactured by the Oerlikon company. Each dynamo is capable of generating a current of 4,000 ampères and 50 volts at a speed of 150 revolutions.

The current is led from the dynamo through four conductors, as three independent alternating currents, differing in phase by 120 degrees, first to a switchboard fitted with ammeters and fuses; from there to a step-up transformer in which the voltage is raised from 50 to 5,000 volts.

The latter is then transmitted to the outskirts of the city of Heilbronn, a distance of about 11 kilometres (6.6 miles) by means of three bare copper wires, 6 millimetres in diameter, mounted upon oil insulators, which are carried upon cross-bars fixed to wooden poles varying in height between 8 and 14 metres. Some distance above these line wires there a barbed steel wire extending throughout the whole distance, which is earthed at every pole, and serves as a lightning protector.

After leaving the step-up transformer at the generating station, there is in each circuit of the long distance lines a hort length of several fine copper wires .15 millimetre in diameter, which fuse when the line is short circuited, thereby serving as a means for disconnecting the line from the generating station in case of urgent necessity.

On the outskirts of Heilbronn the 5,000-volt current is transformed, by means of a step-down transformer, to 1,500 volts, at which tension it is led to the centre of distribution in Heilbronn by means of a triple concentric cable having a copper cross-section of 3×80 square millimetres. From this point it is distributed to transformers (which are about 200 metres apart), in which it is transformed from 1,500 down to 100, at which pressure it is distributed to consumers.

These transformers of 5 and 10 kilowatts are installed in small iron cases erected at street corners or other convenient places, having the appearance of stout columns, such as are seen all over the continent, being generally used for posting advertisements. The transformers are placed in the upper part of the column, the cable connections, etc., being made below. All the transformers were furnished by the Maschinenfabrik Oerlikon, and are the designs of Mr. Brown.

The distribution from these transformers is effected by means of a low tension network, consisting of Siemens & Halske iron-armored, triple-concentric lead-covered cable.

The house connections are made on the three-wire system, with as equal a distribution of lamps and motors between the three circuits as possible. The arc lamps, which are distributed similarly, are run either two or three in series. Below the transmission wires are three test wires of hard drawn copper 1.5 millimetres diameter, which are connected at Heilbronn with three cable test wires. At the generating station these test wires are connected with a switchboard having three voltmeters, by means of which the tension of the low volt distributing current in Heilbronn can be ascertained, and can then be regulated by means of the turbine or the exciting current. At the converting station on the outskirts of the town is a second similar switchboard with a voltmeter and switch, enabling this instrument to be inserted between any two of the three test wires so that the tension at the centre of distribution can also be read here.

By means of a second switch the test wires can be disconnected entirely from the distributing centre, after which two of them can be connected with a telephone circuit thus establishing communication between the generating station and the converting station outside of the town.

At present the motors (Dolivo-Dobrowolsky system) in use in Heilbronn vary in size between ½ h. p. and 6 h. p.; all motors above 2 h. p. are supplied with a starting resistance.

The total load which is being carried at the present time consists of 1,200 lamps of 16 c. p., 14 arc lamps of 8 and 10 ampères, and about 15 h. p. in motors. Three hundred additional lamps, together with 15 h. p. in motors, and six arc lamps will be installed shortly.

The line is so proportioned that the loss in the long distance conductors amounts to 10 per cent., the total loss being 20 per cent. Hence in the three different stages above mentioned the power available in Heilbronn amounts to 160, 320 and 480 kilowatts respectively.

Moonlight Tables for July, 1892.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of July, under his modified form of moon schedule:

TABLE NO. 1.
Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Exting.
1	11:00 P. M.	2	2:35 A. M.
2	11:20	3	3:35
3	11:40	4	3:40
4		4	
5	12:05 A. M	5	3:40
6	12:35	6	3:40
7	1:10	7	3:40
8	No light.	8	No light.
9	No light.	9	No light.
10	No light.	10	No light.
11	8:00 P. M.	11	10:10 P. M.
12	8:00	12	10:45
13	8:00	13	11:10
14	8:00	14	11:40
15	7:55	16	12:05 A. M.
16	7:55	17	12:30
17	7:55	18	12:55
18	7:55	19	1:30
19	7:55	20	2:10
20	7:55	21	3:50
21	7:55	22	3:50
22	7:55	23	3:50
23	7:55	24	3:50
24	7:55	25	3:55
25	7:50	26	3:55
26	7:50	27	3:55
27	7:50	28	3:55
28	9:00	29	3:55
29	9:20	30	3:55
30	9:45	31	4:00
31	10:05	1	4:00

Total hours lighting, 149.10.

TABLE NO. 2.
Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	8:00 P. M.	2	3:35 A. M.
2	8:00	3	3:35
3	8:00	4	3:40
4	8:00	5	3:40
5	8:00	6	3:40
6	8:00	6	12:00 M.
7	8:00	7	12:00
8	8:00	8	12:00
9	8:00	9	12:00
10	8:00	'0	12:00
11	8:00	'1	12:00
12	8:00	12	12:00
13	8:00	13	12:00
14	8:00	14	12:00
15	8:00	15	12:00
16	8:00	16	12:00
17	8:00	18	1:00 A.M.
18	7:55	19	1:30
19	7:55	20	2:10
20	7:55	21	3:50
21	7:55	22	3:50
22	7:50	23	3:50
23	7:50	24	3:50
24	7:50	25	3:55
25	7:50	26	3:55
26	7:50	27	3:55
27	7:50	28	3:55
28	7:50	29	3:55
29	7:50	30	3:55
30	7:50	31	4:00
31	7:45	1	4:00

Total hours lighting, 195.45.

Determination of Temperature Coefficient of Aluminium.

BY W. P. MARR AND R. W. HEARD.

Having just completed a series of experiments on the determination of the temperature coefficient of aluminium at the electrical laboratory of the Lehigh University, and thinking they might possibly prove interesting to those dealing with that metal, we give the results.

The wire used was 188 centimetres of No. 14 (B. & S. gauge), its impurities being: Iron, .764 per cent.; silicon, .196 per cent.; copper, trace; carbon, undetermined (very low).

Sir William Thomson's equipotential method was used in determining the absolute resistances at the different temperatures. The method is shown in Fig. 1.

The variable resistance (used as standard) was a carefully calibrated piece of No. 22 (B. & S. gauge) tinned copper wire, used on a slide-meter bridge. Connections were made

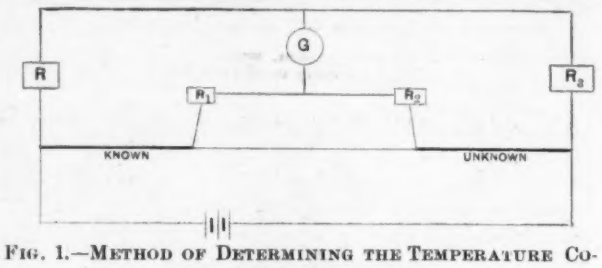


Fig. 1.—Method of Determining the Temperature Coefficient of Aluminium.

for the varying temperatures of the leads at each observation. Melted paraffin was used in obtaining temperatures above 90 degrees C. Three readings were made at each temperature, using different arrangements of resistance R, R^1, R^2, R^3, and the mean of these readings taken. A d'Arsonval dead-beat galvanometer and resistances calibrated by Prof. Anthony were used.

In Fig. 2 is shown a curve plotted from the effect of temperature on the resistance of this metal. The temperature coefficients as calculated from these experiments are as fol-

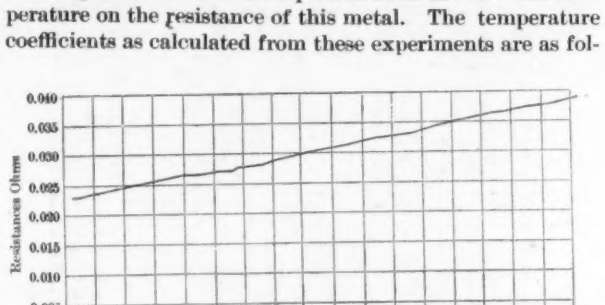


Fig. 2.—Curve Showing Temperature Coefficient of Aluminium.

lows, the mean temperature of the air, 15.6 degrees C., being used as the base.

Temp. centigrade.	Temp. coefficient.	Temp. centigrade.	Temp. coefficient.	Temp. centigrade.	Temp. coefficient.	Temp. centigrade.	Temp. coefficient.
1.00	.00434	23.40	.00322	57.80	.00329	116.20	.00367
1 05	.00418	27.95	.00335	60.20	.00327	122.10	.00381
1.10	.00423	33.80	.00337	63.55	.00329	130.70	.00383
1 35	.00428	40.15	.00328	66.95	.00326	135.65	.00381
1.45	.00428	41.45	.00324	72.45	.00354	142.50	.00381
1.55	.00427	45.50	.00319	70.60	.00343	149.15	.00380
1.65	.00418	47.60	.00325	75.60	.00347	156.10	.00379
2 10	.00434	51.00	.00329	81.80	.00358	164.70	.00381
9.10	.00385	53.90	.00329	94.55	.00366	166.95	.00379
13.40	.00427	55.60	.00319	105.85	.00383	171.30	.00379

A Reply to the Attack on Multiphase Current Systems.

BY M. VON DOLIVO-DOBROWOLSKY.

It is peculiar that in the two countries, the United States and England, where engineering and the industries are so well developed, a sort of hatred toward anything new has lately manifested itself. This is noticeable from the rather bitter tone in which the subject of multiphase current systems for the transmission of power have been treated in articles and discussions. Although this discussion is directed chiefly against the improvements made by myself, which have enabled the multiphase current system to compete with all other electrical systems, it nevertheless pleases me that the conservatism, prejudice and malignity are apparently shown only in this special direction, and that every other new development in the electrical field, be it of ever so little importance, is greeted with jubilation and pleasure. The many articles in electrical journals in which an attempt is made to decry the multiphase current, on the other hand, prove that the matter in question is by no means of small importance.

The steady progress of the application of the multiphase current system, especially in large projects, would alone be sufficient to prove in time that the opponents are in error. But in order to make it easier for impartial persons to judge for themselves, I desire to make a short reply to some of the attacks directed against me and my work. These attacks may be summarized as follows: First, against the use of more than two phases; secondly, against pretended objectionable properties of multiphase motors in general. The battle between two and three phases I thought had already been ended, especially as such authorities as Mr. Gisbert Kapp, and even Prof. Ferraris, and others acknowledged that I was right in this point, namely, that a greater constancy and uniformity in the rotation of the magnetic field will be produced the greater the number of phases employed. But the article of Mr. Kelly,* recently published, appears to prove that there are still some who do not acknowledge that I am right in this.

I do not care to go into mathematics, but will limit myself to ordinary logic. If the motor had an absolutely constant and uniformly rotating field it should develop during every moment absolutely the same mechanical energy, and should, therefore, also consume during every moment absolutely the same amount of electrical energy. The electrical energy which is delivered to the motor is in watts. With a *sinusoidal current* the watts also follow a sine law. That this is the case, it will hardly be possible to dispute. On the other hand, it is evident that if we have two alternating currents which differ in time by one-quarter of a phase, the waves of the watts which the motor receives differ also by one-quarter of a period. The energy which the motor receives is the sum of the watts of the two currents, for how could it be otherwise? But the sum of the two sine curves of the watts is not constant and varies by about 40 per cent. It follows from this that the motor receives energy from the line which is not constant from one moment to the next, but which pulsates. As long as the mechanical inertia of the motor is not considered in the theory of the motor, it may be assumed that the work delivered by the motor is likewise not constant from one moment to the next.

Whether this is to be explained by saying that the field intensity alone pulsates, or that the speed of rotation of the field oscillates, is quite immaterial. In any case we see that the speed and torque of a two-phase motor cannot be as uniform as it would be if the field was rotated mechanically and had a permanent magnetism. The more phases we use the nearer will the watt curves come together, and the more uniform will be the electrical energy which is applied to the motor and the mechanical energy that is given out by the motor. It is to be hoped that this will be sufficient for the advocates of two phases, and that they will from now on lay aside mathematical and geographical proofs which appear to refer to mathematical points, single poles and wattless currents.

The matter will be quite different if we depart from sinusoidal curves and assume an artificially shaped curve, as, for instance, such as are flattened. One can, of course, picture to one's self two such alternating currents which have a constant sum. This was, for instance, suggested by Prof. Silvanus Thompson during the discussion of my paper at the Electrical Congress in 1891 in Frankfort. I replied to it, and my explanation was unanimously accepted, namely, that a particular form of current curve could be developed for only one particular output of the machine. The reaction of the armature currents in the machine, the self-inductions, particularly of the motor (which for different loads are entirely different), the electrostatic capacity of the line, a possible multiple transformation, will all change the form of a curve which may have been worked out with great care; furthermore, they will always make it approach the sine curve. There has doubtless been sufficient proof published in the electrical literature that the sine form is the only one which is stable and easily produced. If by reason of some improper proportioning of the dynamo it produces any other currents (for instance, pointed waves), it will always be possible in a motor to have a uniform rotation of a constant field, if one will only use very many phases. As three-phase currents require no more leads than when two-phase are employed, the use of three phases is not accompanied by any disadvantage, and I am sure that the two-phase current now belongs to the past. If one wishes to obtain more phases with three leads one can use the method that I suggested a year ago, and called "double-linking,"† which has been described in a number of papers and is patented by me in the United States.

There has also been much said against the properties of the three-phase current motor. It is claimed that the motor cannot be started loaded. How do these critics know this? I have always claimed in my writings and papers that the motors which I have built developed a large torque at starting, which statement is based on *experience*. If it is denied that they do, then I can only pity those who have not understood how to calculate and construct a motor which does this; and if it is proved theoretically that these motors have no starting torque, it is only another proof that theories can be incorrectly developed. But if there still exists a doubt, there remains only for me to request the unbelievers to examine my motors. Then I will take pleasure to connect large as well as small motors with a brake and start them with the brake applied; this I did repeatedly before I made the published statement.

Mr. Stanley and many others claim that 10 and even 20 h. p. transformers will be necessary for a two horse power rotary field motor, because such a large exciting current is required. When Mr. Stanley adds to this that it is the "engineering practice" here, I must say that with us "engineering practice" demands from one who publishes an attack against another that he should first make inquiries and study up the subject, and not simply repeat without reserve what he has heard from some Tom, Dick or Harry.

I published in the *Elektrotechnische Zeitschrift* complete data of tests made with a two horse power motor in April,

* See The Electrical World, April 16, 1892, p. 259.
†See The Electrical World, Sept. 9, 1882, p. 194.

1891. Those who will study this article will find that the motor when running unloaded has a phase difference of about 72 degrees between the current and the voltage, but when delivering two horse power this was only 28 degrees, and with three horse power 22 degrees. With normal load, namely, two horse power, it consumed 1,830 true watts, as compared with 2,079 apparent watts. It is plainly stated that with a load of two horse power there were 9.9 ampères in each of the three currents at 70 volts. Therefore one does not require a 20 h. p. transformer for running such a motor, but only one which is built for three times 9.9 ampères at 70 volts, namely, for 2,079 watts; this would equal only about 2.8 h. p.

In the same article I call especial attention to this very small phase difference, and state the ratio

$$\frac{\text{1,830 true watts}}{\text{2,079 apparent watts}} = .88 = \text{cosine of angle of lag,}$$

is a very favorable one for such a small motor, aside from the total efficiency of about 80 to 81 per cent. at full load, and 75 per cent. at half load, and the possibility of delivering four horse power for a short time without great sacrifice in economy. If theory has led to false conclusions in this case as well, and requires that the exciting current should be greater than was actually required, I must most decidedly request the critics not to rush into print with their theories so soon after they have developed them, but to make inquiries first whether the facts and theories are in accordance with each other.

BERLIN, May 29, 1892.

Test of the Neversink Mountain Electric Road.—VI.*

BY HERMANN S. HERING AND WILLIAM S. ALDRICH,
OF JOHNS HOPKINS UNIVERSITY.

VI.—THE TEST OF THE POWER PLANT (CONTINUED).

Summary of Power Distribution During the Test of the Plant.—The results of this test, plotted in Fig. 16, and the deductions therefrom collected under Table VIII.,† have been summarized in the following table, X., which shows the successive distribution of the power delivered from that of the hydraulic head to the available horse power at the car axle; also the respective losses in the several transmissions:

TABLE NO. X.—SUMMARY OF POWER DISTRIBUTION.

Power Delivered: Section in which reading is taken.	I.	II.	Total.
Hydraulic H. P. delivered to turbines.	182.7	234.0	197 8
Turbine H P. delivered to trans machy..	85.1	138.9	101.0
H. P. delivered to dynamos	50.5	95.8	63.7
E. H. P. " " line	38.5	82.0	51.3
E. H. P. " " car motors	36.2	77.1	48.2
H. P. " " car axles	25.4	54.0	33 7
Power Lost:			
Turbine friction H. P	97.6	95.1	96.8
Transmission mach'y friction H. P	34.6	43.1	37.3
Dynamo losses	12.0	13.8	12.4
Line losses	2.3	4.9	3.1
Car motor and gearing losses	10.8	23.1	14.5
Total losses Hyd. Hd. to car axle	157.3	180.0	164.1
H. P. available at car axle	25 4	54.0	33.7
Total hydraulic H. P. delivered	182.7	234.0	197.8

The values given above are of course mean values, being obtained chiefly from the integrations of these sections of the curves plotted in Fig. 16. The integrated means of these curves of turbine and dynamo performance cannot be interpreted as necessarily representing the actual performance at any particular moment. The sudden variations in the external load and the consequent irregular character of the variations of the station momentum (plotted in Fig. 17), with an uncertain time lag in governing and very great changes in speed—all enter as disturbing elements considerably affecting the integrated means of any selected portions of a test of this character. However, these values show in a general way the average performance of the plant and indicate quite clearly the proportional distribution of power.

The hydraulic and turbine horse power with the turbine friction, and the E. H. P. delivered to the line, have been taken directly from Table VIII. The horse power delivered to the dynamos was obtained from a determination of the dynamo losses at various loads, from data respecting the dynamo performance kindly furnished the authors by the Edison General Electric Company, through the courtesy of its engineers. These losses in the dynamo, deducted from its output, gave the power delivered; this value deducted from the turbine horse power gave the amount lost in the transmission machinery friction. The E. H. P. delivered to the car motors was obtained by deducting the line losses from the dynamo output. These line losses were based on a mean value of the line efficiency of 94 per cent., as given in Table III. (THE ELECTRICAL WORLD, page 395, June 11, 1892). The car motor and gearing losses include all the losses—electrical and mechanical, from motor terminals to car axle—and represent an efficiency of 70 per cent. for the aggregate motor performance, as they were steadily run upgrade, usually at full switch position, and making but few stops—conditions for very efficient working. Deducting these losses from the power delivered to the motors gave the horse power available at the car axles.

Summary of Proportional Losses and Efficiencies.—The interesting relations between the successive values in the distribution of the power, as well as the successive losses, have been computed for the respective sections of Tables VIII. and X., and the results tabulated in a form convenient for reference in the following table:

TABLE XI.—SUMMARY OF PROPORTIONAL DISTRIBUTION AND EFFICIENCY.

Proportional Parts of Full Load: Section in which reading is taken.	I.	II.	Total.
Hydraulic load, per cent. of full Hyd. H. P.	35.1	45.0	38 0
Turbine load, per cent. of full Turb. H. P.	20.4	33.4	24.3
Dynamo load, per cent. full dyn. output	14.4	30.6	19.2
Motor load, per cent. full motor output.	14 5	24.6	17.2
Percentage Distribution:			
Turbine friction, per cent. loss	0.534	0.406	0.489
Transmission machinery friction	0.189	0.184	0.189
Dynamo	0.066	0.059	0.063
Line	0.013	0.021	0.016
Car motor and gearing losses	0.059	0.099	0.073
Available power at car axle	0.139	0.231	0.170
Total hydraulic power	1.000	1.000	1.000
Summary of Efficiencies:			
Efficiency of coupled turbines	46.6	59.4	51.1
Efficiency of transmission machinery	59.3	69.0	63.1
Efficiency of dynamos in parallel	76.3	85.2	80.5
Efficiency of line, mean of total length	94.0	94.0	94.0
Efficiency of car motors	70.0	70.0	70.0
Efficiency from Hyd. H. P. to line	21.1	35.0	26.0
Efficiency from Hyd. H. P. to car axle	13.9	23.1	17.1

From Hydraulic H. P.	To line H.P.	To car axle H. P.
Efficiency at half load of dynamos, which is 50 per cent. turbine capacity, or 57 per cent. full Hyd. H. P.	45.0	29.3
Efficiency at full load of dynamos, which is 95 per cent. turbine capacity or 93 per cent. full Hyd. H. P.	55.2	36 5

The several results in the above table are for an average turbine speed of 100 revolutions, as this was the average during the test. At this speed the full hydraulic horse power of the coupled turbines, as well as the actual turbine horse power, were taken from the curves of Fig. 11 in a preceding article (THE ELECTRICAL WORLD, page 412, June 18, 1892). The same remarks apply here which have been formerly made with regard to Table X., in reference to the interpretation of the several values in connection with the integrated means for the respective sections in which the readings have been taken. As before, it has been found necessary to work upon an average speed throughout the computations, in order to arrive at results that are at all comparable.

The proportional part of the dynamo load is based upon the rated performance of the two 100 k. w. generators in parallel, while that of the car motors is based upon the rated armature output (25 h. p.), there being four cars on the road during the interval of section I., and five cars during section II. The portion of the table in which the authors have collected the several percentages of losses and distribution is the usual form in which the summarized results are tabulated for comparison. These values show the actual percentage distribution of the hydraulic power given to the plant. They are obviously obtained by dividing the several values of the power losses and the power available at the car axle, given in Table X., by the total hydraulic horse power for each section.

The portion of Table XI. containing the summary of efficiencies shows the efficiency of the power transmission at its several stages, and was obtained by dividing the power given out at each new stage of its transmission by the power delivered.

The efficiency of the coupled turbines has been taken from Table VIII., while that of the transmission machinery is from the values given in Table X. The efficiency of the dynamos was obtained from a determination of the efficiency of the 100 k. w. dynamo at various proportional parts of its full load, from data furnished by the Edison General Electric Company. The computations from this data have been plotted in the curves of efficiency and power losses of the 100 k. w. Edison dynamo, as shown in Fig. 21, for the various proportional parts of the full dynamo load, expressed in per cent. of the maximum output of 100 k. w.

As the mean drop in voltage for the total length of the line is about six per cent., the efficiency of the line transmission is 94 per cent., as given in Table III. From this table it will also be seen that for the normal currents of the test the maximum drop was 10.5 per cent., and the minimum 3.9 per cent.; but the same remark applies here, regarding constancy of conditions with respect to the line losses, that has been previously made with regard to the station losses; in the latter case the mean speed of 100 revolutions was taken for obtaining the proportional values of the station performance, and in the former case a mean efficiency of 94 per cent. taken for the line transmission. So also the efficiency of the car motors, taken as 70 per cent. from the motor terminals to the car axle, is for the average condition under which these 25 h. p., single reduction, Edison motors are usually operated on this road. From an inspection of the proportional part of the motor load for each section, it might appear that the motors were working at a very low per cent. of their capacity, too low for an efficiency of 70 per cent.; but it must be remembered that only half the motors out on the road are in operation at any one time, as the car route schedule has been arranged so that only half the number of cars go up grade at any one time, the others being on down grades. The motors in actual operation are working at good average loads, and in many cases during this test they were far above the requirements of ordinary passenger traffic.

The efficiency of the station from the hydraulic horse-power to the dynamo output at the line, though apparently low, is quite within the range of ordinary station performance, when the proportional part of the full capacity of the station for the several sections is taken into consideration. It is essential to state to what proportionate load any station efficiency corresponds, otherwise very erroneous conclusions may be drawn from carefully made tests. The efficiency for the whole transmission, from the hydraulic horse-power to that available at the car axle, is a final result which such a test anticipates, and here shows, as usual, what a small percentage of the power supplied to the prime movers is ultimately available for traction purposes.

Reference to Table IX. will show values for the electrical horse power much above the average of the sections for special consideration during the test. Computations based upon the station performance under these heavy loads show that the station efficiencies for the maximum load of 185 E. H. P. were 51.4 per cent., and for the mean load of 99 E. H. P. were 38 3 per cent.; while the efficiencies from the hydraulic horse power to the car axle were, respectively, 33.8 per cent. and 25.2 per cent.

The two sets of values given lastly in Table XI. are inserted as a matter of interest, to show the proportional relation between the dynamo and turbine capacities at half and full load of the dynamos, with the respective station efficiencies in the first column and the total efficiency in the second.

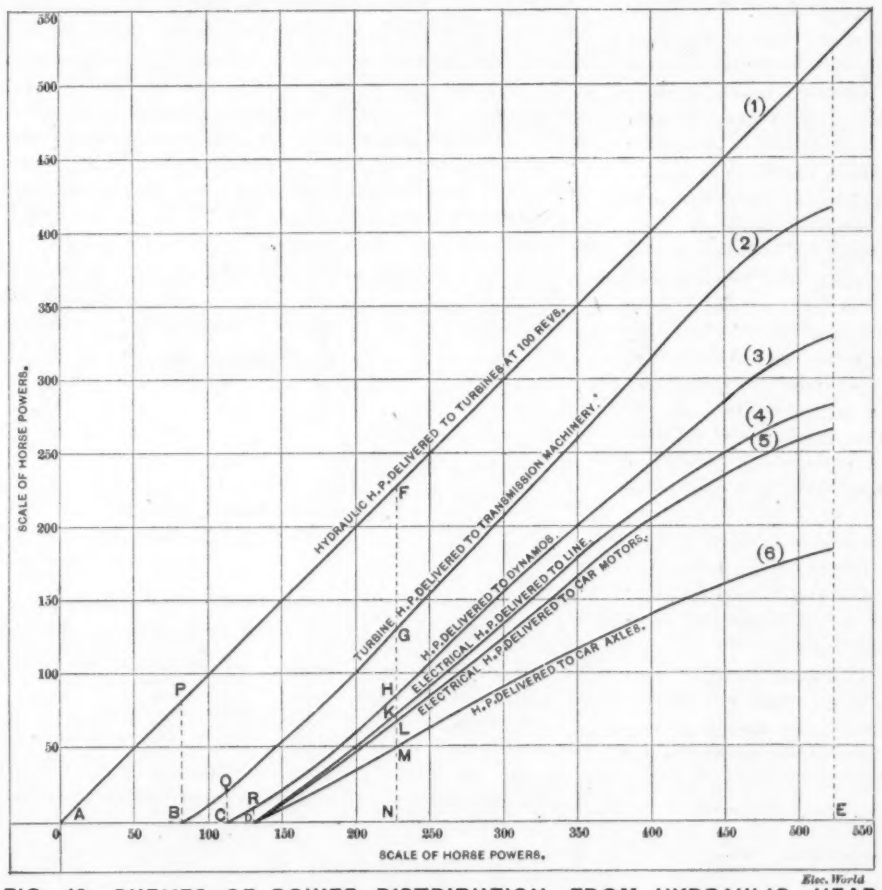


FIG. 19.—CURVES OF POWER DISTRIBUTION FROM HYDRAULIC HEAD TO CAR AXLE.

Curves of Power Distribution.—The mean values for the several losses in the distribution of the power (mean speed of turbines, at 100 revolutions) have been plotted in the curves in Fig. 19. These do not represent the means, integrated or otherwise, obtained from few or many observations, nor do they show just the state of affairs at any one moment. They are rather to be considered as general average values showing, by simple inspection, the proportional distribution of losses, and the final power available at the car axle for the various horse powers up to the maximum hydraulic capacity of the station. It would, of course, be possible to obtain such a distribution of the power as is here shown if the turbine speed could be maintained constant for such a length of time that the station performance would settle down to steady conditions, on the one hand, while the distribution and load of the cars out on the road should be almost uniformly maintained, on the other hand. The disturbing element in the station performance as here represented is the variable turbine speed, and with regard to the road conditions it is the varying position of the cars *en route*, and the changing loads on the motors due to varying grades and the somewhat irregular passenger traffic. However, taking all these matters into consideration, the curves convey a very good idea of the relations between the successive losses.

The diagonal line marked (1) represents the H. H. P. delivered to the turbines at 100 revolutions, and for which either the horizontal or vertical scale of horse powers may be used. The curve (2) is the T. H. P. delivered from the turbine shaft to the transmission machinery. It has been obtained for the several hydraulic horse powers from the curves of Fig. 12 (THE ELECTRICAL WORLD, page 412, June 18, 1892), by stepping off on the respective H. P. P. ordinates

*For the first five sections of this article see THE ELECTRICAL WORLD of May 28, June 4, 11, 18 and 25, 1892.

†Referring to Fig. 16 and Table VIII. of preceding article, THE ELECTRICAL WORLD, June 25, 1892.

the friction horse power of the coupled turbines, this value being twice the horizontal distance between the H. H. P. and T. H. P. curves of Fig. 12 for any given H. H. P. The horizontal distance, *A B*, Fig. 19, represents the H. H. P. required to drive the two turbines with no output; and that for any other turbine output, as *G N*, is measured by the horizontal distance, *A N*. It is to be carefully noted that the horizonal and vertical distances for any points, as *A B* and *B P*, or *A N* and *N F*, are equal only when referring to points on the diagonal line (1) of H. H. P.

The curve of horse powers delivered to the dynamos (3) was obtained from a curve of power losses in the transmission machinery at the constant speed given above, and which losses have been set off from the points along (2) for any given

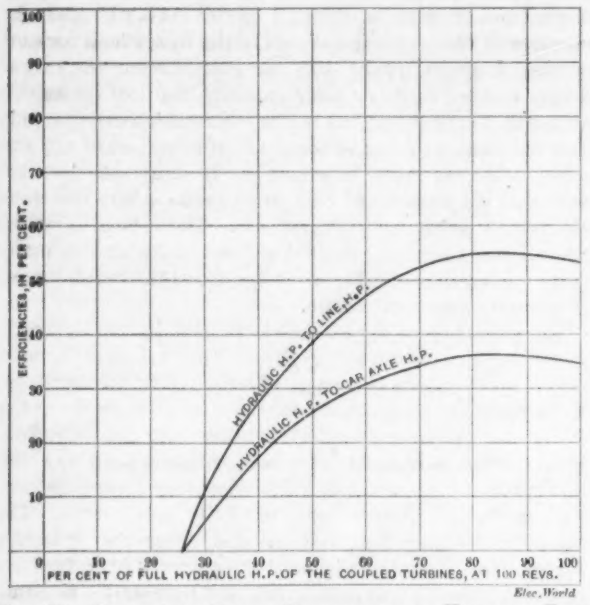

EFFICIENCIES IN PER CENT.
HYDRAULIC H.P. TO LINE H.P.
HYDRAULIC H.P. TO CAR AXLE H.P.
PER CENT OF FULL HYDRAULIC H.P. OF THE COUPLED TURBINES, AT 100 REVS.
Elec. World

Fig. 20.—Curves of Plant Efficiency at Various Proportional Parts of Full Hydraulic Capacity of the Station.

horse power delivered from the turbine shaft. The losses in the transmission machinery were obtained partly from observations made during the test and from calculations based on the dynamo output and efficiency. The point *C*, and its ordinate *Q C*, refer to conditions of the station test, when all the available T. H. P. was absorbed in the transmission machinery, the dynamos being unclutched.

The curve (4) of E. H. P. delivered to the line shows the dynamo output as measured at the switchboard, and its vertical distance, as *H K*, at any point, represents the total mechanical and electrical losses in the dynamos, for that proportional part of the dynamo output. As before, the point *D* and its ordinate *D R* correspond to conditions in which all the available T. H. P. is absorbed in the transmission machinery and dynamo losses, fields excited but zero ampères at the switchboard. The efficiency of the dynamos at any particular output is shown by the ratio of the respective ordinates of (4) and (3), as *N K* divided by *N H*. The losses represented by the vertical distance at any point between (3) and (4), as *H K*, comprise the following: Mechanical friction of the journals in the bearing and of the air resistance, 1.33 h. p., and was assumed fairly constant under uniform speed at the different loads; hysteresis, Foucault currents and losses on the shunt fields, 4.22 h. p., also fairly constant under the same conditions, and the variable C^2R losses in the armature and the series field coils calculated from resistances with temperature corrections.

The E. H. P. delivered to the car motors, curve (5), has been obtained by setting off vertical distances, as *K L*,

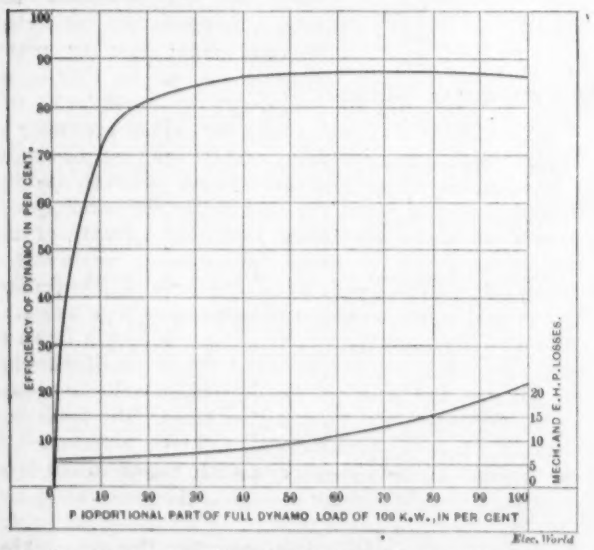

EFFICIENCY OF DYNAMO IN PER CENT.
MECH. AND E.H.P. LOSSES.
PROPORTIONAL PART OF FULL DYNAMO LOAD OF 100 K.W., IN PER CENT
Elec. World

Fig. 21.—Curves of Efficiency and Power Losses of a 100 K. W. Edison Dynamo.

from (4) which are uniformly 6 per cent. of the ordinates of (4), as *K N*; this per cent. of line losses being the mean already referred to.

The horse power delivered to the car axle, curve (6), was drawn by deducting 30 per cent. from the measured ordinates of (5), the combined efficiency of the motor and gearing having been taken at 70 per cent., the reasons for which were given above. Finally, the ordinates of curve (6), as *M N*, represent the horse power available at the car axle for traction at any particular points within the limits of the preceding curves.

Curves of Plant Efficiency at Various Loads.—From the values obtained from curves (1) and (4) of Fig. 19, the efficiency of the station was computed for various hydraulic horse powers up to the maximum (shown by the ordinate at *E*), expressed as proportional parts of the full hydraulic horse powers of the coupled turbines, at 100 revolutions. These respective values for the station efficiencies were plotted in Fig. 20.

Similarly, from curves (1) and (6) of Fig. 19, the total efficiencies from the hydraulic head to the car axle were computed and plotted on the same base in Fig. 20. It is interesting to note the somewhat characteristic direction of these curves as compared with the efficiency curves of individual prime movers and motors. Neglecting for the moment the efficiency of the transmission machinery and the line, it might be inferred that the combined efficiency of turbines, dynamos and motors when plotted in one curve of aggregate efficiency would show the general features of the individual efficiency curves.

Inspecting the curves of Fig. 20, it is apparent that 25 per cent. of the maximum H. H. P. is required to overcome all the station losses at this speed, with no electrical output. The maximum values occur at 85 per cent. of the full H. H. P. capacity of the station, and are respectively 55.8 per cent. for the station efficiency and 36.7 per cent. for the total efficiency. At full load, under the same steady conditions, the efficiencies are respectively 54.0 per cent. for the station and 35.5 per cent. for the total.

A Dynamo Indicator, or Instantaneous Curve-Writing Voltmeter.*

BY GEORGE S. MOLER.

In connection with the work in dynamo and motor testing in the physical laboratory of Cornell University, it was found desirable that some method should be devised which would enable the student experimenting to very quickly explore the field of a machine, so that he could study some of the changes which might take place even in a few seconds. The double brush method of Dr. S. P. Thompson, and the single brush method of Mr. W. M. Mordey, are in

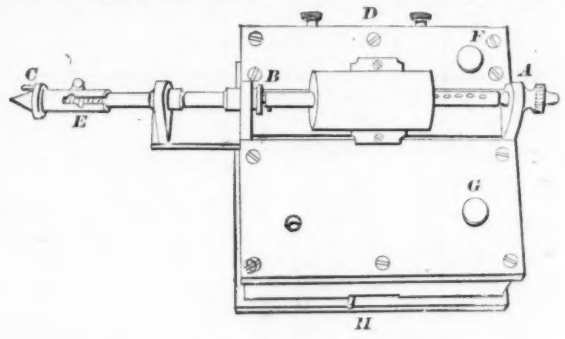


Fig. 1.—A Curve-Writing Voltmeter.

use and give excellent results, but either of these methods requires a few minutes at the very shortest to obtain the data for a single curve.

To attempt to meet this want the writer devised the instrument which is the subject of this paper. It is intended to be used in tracing those curves which show the changes in potential of the two ends of a single coil of the armature, and also those showing the changes between one brush and one of the commutator bars, as the armature revolves. The instrument consists in the main of a very rapidly vibrating needle of a voltmeter, and a smoked cylinder against which the pointer is made to press at the required moment. The curve is traced during a single revolution of the armature and is then easily transferred to paper, and is thus placed in a permanent form to be studied at leisure. The voltmeter, which is inclosed in the body of the instrument, is of the permanent magnet form. The needle is of soft iron, and is very short, and held at zero by being placed between the poles of a powerful steel magnet. The pointer is made of aluminium and is quite short. It is shaped so as to be as light as possible, and so that the air cannot offer much resistance to its motion. The cylinder is of metal and very smoothly finished, so that it will offer little resistance to the movement of the pointer. It is mounted upon a short shaft and is arranged so that it can be slid to several different positions; a spring dropping into notches holds it at each place. The stationary pivot at *A*, Fig. 1, is made with a spring so that the cylinder can be quickly removed for smoking or for transferring the curves. This short shaft is connected with the driving shaft of the instrument by projecting pins at *B*, so that it will always maintain the same relative position with the pin at *C*. The pin *C* is attached to a sliding sleeve which is pushed toward the point of the shaft by a spring. A hole or a pin in the end of the armature shaft is to engage with the pin *C*, so that the cylinder will always have the same relative position with the armature. To operate the instrument two insulated wire hoops or bands are to be wound around some convenient part of the shaft or commutator, and one is to be connected to one commutator bar and the other to one of the adjacent ones. Small brushes are to be made to press upon these bands, and they are to be connected to the binding screws at *D*. The cylinder is then lightly smoked by removing it and revolving it over a candle or gas flame; then it is placed in position. The sleeve carrying the pin *C* is pulled back and latched in the notch *E*. Then the point is pressed into the centre hole in the end of the armature shaft; this will put

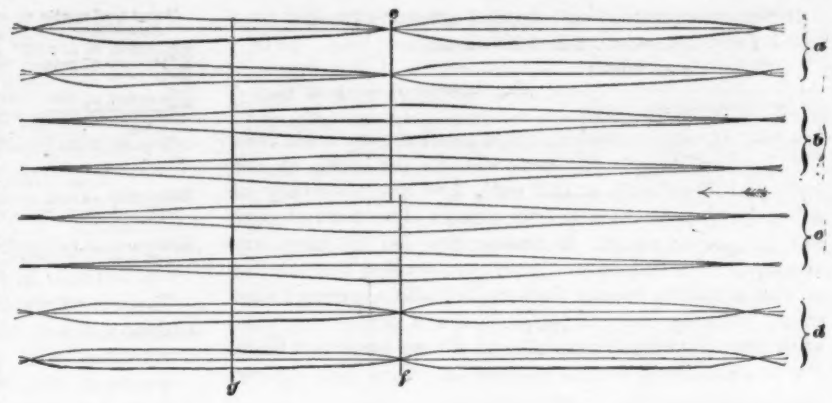


Fig. 2.—Curves Taken from the Moler Instrument.

the drum in motion; then by letting the projecting knob strike the finger the sleeve will be unlatched, and will spring forward and engage with the pin in the end of the armature shaft. Then pressing the button *F* closes the circuit, and pressing *G* brings the pointer against the drum. *H* is a reversing switch. The base line of the curve is drawn by pressing *G* only. Another form of curve will be obtained if one of the terminals of the indicator is attached to one of the permanent brushes of the dynamo, and the other to one of the brushes pressing upon the band connecting with one of the commutator strips. Also a temporary exploring coil may be wound upon the armature, and its terminals may be connected to the indicator.

The voltmeter of the indicator is necessarily one of low potential, so that the changes in a single coil will produce a suitable deflection. For greater changes of potential a resistance must be used in series with it. The curves are transferred from the smoked cylinder by dampening a sheet of paper and then rolling the cylinder over it. Three distinct copies have in this way been made from one set of curves. One of these instruments has been built and has been tested in various ways and is found to give very satisfactory results. The rate of vibration of the needle was determined while the pointer was in contact with the revolving drum and was obtained as follows: A current was applied so as to produce a deflection, then while the drum was revolving at over a thousand revolutions per minute the needle was brought in contact with it and the circuit was then broken, making a wavy line extending part way around the drum before it died out. The average rate of oscillation as determined from over 40 measurements was 103 per second, and the damping effect was so great that in .04 of a second the needle was brought to rest. It was also observed that the deflection was not changed by bringing the pointer in contact with the revolving drum.

One of the desirable features of the indicator is the rapidity with which the curves can be made. The cylinder full of curves, eighteen in all, with their base lines, were made in 73 seconds, so it is seen we can explore the field many times while a dynamo is charging up just after being started, or while any great change in load is being made.

In Fig. 2 are shown some of the curves produced by exploring the field of a 20-ampère shunt-wound dynamo of the consequent pole type. The dynamo was driven at a speed of 1,075 revolutions per minute, and had an automatic regulator, which held it at 115 volts, with slight varia-

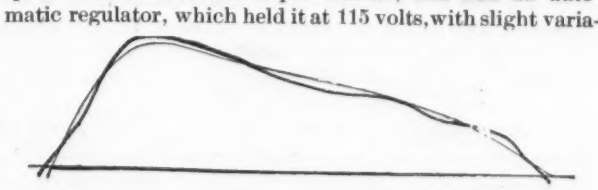


Fig. 3.—Comparison of Curves Taken by Two Methods.

tions. The curves *a* and *b* were made while 20 ampères were flowing in the main line, and *c* and *d* while the outside circuit was broken. The curves *a* and *d* show the changes in potential of the two ends of a single coil. The line *g* shows the position of the centre of the pole piece, and the arrow the forward direction of the curves. The double curves upon each base line were made by reversing the terminals by means of the switch *H*. The line *e* is the position of the neutral point when 20 ampères were flowing, and *f* its position when the line is open. The difference in shape of the curves shown at *a* and those at *d* is very marked. The curves *b* and *c* were made by connecting one terminal to one of the dynamo brushes, and the other to one of the brushes connected to one end of a coil. These also show the change of the neutral point, and a change in shape for open and closed circuit.

The instrument is calibrated by comparison with a

* A paper read before the American Institute of Electrical Engineers.

standard voltmeter. For each reading on the voltmeter a line is drawn around the drum. When the pointer is not in contact with the drum some of the effects of inertia can be noticed, but when contact is made they seem to almost disappear, and corrections may be applied to compensate for the lag on that account.

To test the reliability of the instrument one of the 20-ampère curves for half a revolution and similar to *a*, Fig. 2, was taken at random, and the data taken by two students, to obtain which they worked at least an hour, and had to contend with fluctuating speed and voltage. These two curves were drawn to the same scale and are shown in Fig. 3, the heavier and most fluctuating line being by the experiment. The agreement is about all that can be expected, so it seem that the instrument is capable of reliable results.

In the discussion which followed, Prof. Crocker said that the ordinates are so small that the character of the curve is not clearly shown. In other words, the curve is too nearly a straight line to clearly show any particular character. For example, referring to diagrams in Fig. 2, they look too much alike. If this simple apparatus, with all its convenience and rapidity of action, can give a curve which truly represents the curve of a dynamo in a way that is available, it certainly is a very useful apparatus. It of course pretends to be an apparatus similar to the ordinary steam engine indicator; and such an instrument would be very useful to the electrical engineer, and would take the same place in electrical engineering that the steam engine indicator does in steam engineering. There is no doubt that such an instrument is needed—in fact, almost required—in electrical engineering, and we would all like to see such an instrument perfected. He asked whether greater amplitude of vibration or height of ordinate could be obtained without introducing errors due to inertia?

Dr. Nichols replied in the absence of the author, saying that the point was very well taken, and illustrated what may be considered the chief fault of the instrument in its present form. "It should be said, however, that while these curves are of such small ordinate that they cannot be readily studied directly, they will bear measurement. The line is a very fair one, and by measuring and multiplying the line it seems to bear a close inspection. I do not know whether it would be practical to multiply it many times or not. I think that without great change in the construction of the instrument the maximum is about reached."

Mr. Roberts suggested to photograph it at an angle and enlarge it at the same time; that would preclude the liability of error from small measurements.

Mr. Emery suggested that it could be photographed through a cylindrical lens, and in that way it would be enlarged one way without being enlarged the other. A similar experience has been gone through with in connection with the steam engine indicator. It is no trouble to enlarge it if the small copy is all right in itself.

Notes on Wiping Contact Methods for Current and Potential Measurement.*

BY PROF. BENJ. F. THOMAS.

In the discussion on Mr. Milton E. Thompson's paper on "A Study of an Open Coil Arc Dynamo," read before the Institute on the 21st of May, 1891, Dr. Geyer referred to some work done at Stevens Institute by the writer, in which work the wiping contact method seems to have been

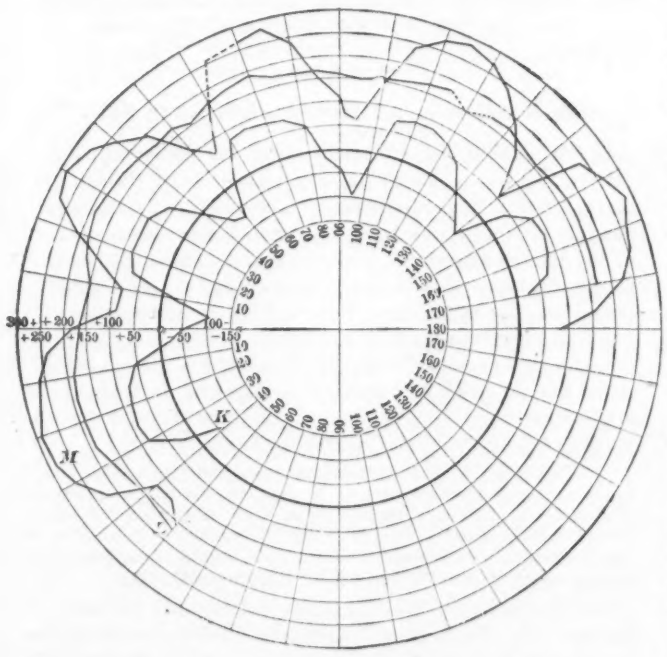


FIG. 1.—A STUDY OF WIPING CONTACT METHODS.

used for the first time. The following brief account of the work is presented at the request of several members of the Institute.

In the latter part of July, 1880, President Morton requested the writer to determine the power required to maintain the arc of a Brush arc light, supplied with current by a Brush dynamo machine.

Ammeters and voltmeters were then unknown, and among the electrical instruments in the Stevens laboratory the most convenient for the purpose seemed to be a tangent galvanometer for the current measurement, and a condenser and Thomson galvanometer for potential. The condenser was a one-third microfard standard, and the galvanometer a 7,000 ohm, four-coil astatic, both made by Elliott Bros. As every one knows would be the case, trouble was encountered the moment the potential readings began. The condenser being first connected to the two carbons, and then discharged through the galvanometer, the successive throws of the needle were found to vary widely, and what seemed at the time most curious, *the throws were sometimes to the right, and sometimes to the left.* A little re-

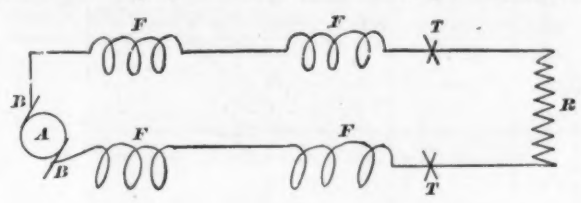


FIG. 2.—A STUDY OF WIPING CONTACT METHODS.

flection showed that while varying throws in one direction might be due to varying resistance of the arc, throws in opposite direction could only be produced by an actual reversal of the potentials of the two carbons. This, of course, led to the conclusion that the potential difference at the terminals of the dynamo must vary with the angular position of the armature as it revolved. Wishing to know the character and magnitude of the variation, the writer devised what is now known as the wiping contact method, the natural and only expedient for the purpose.

The condenser was joined, through the usual discharge key, to the terminals (or other points) of the dynamo, by two well insulated wires. At the dynamo one of these wires was cut, and the cut ends attached to a pair of well insulated springs of flat metal, mounted on the outer end of a radial arm, the latter fastened to a horizontal rod, coaxial with the armature. A well insulated piece of metal was fastened radially on the face of a disc attached to the armature shaft, and the two brushes set so that they were lightly touched by the radial strip at each revolution of the armature. A pointer attached to the horizontal shaft carrying the radial arm and contact springs, moved over a divided circle on the support of the arm, so that angular positions could be read. The contact device thus acted as an open circuit key, the closing of which, and the consequent charging of the condenser, could only take place when the armature was in a definite position. The process of obtaining the curve of potentials through a revolution of the armature is now so familiar that further description is unnecessary.

In carrying out the examination of the machine, a non-

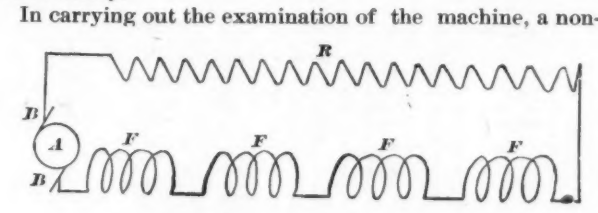


FIG. 3.—A STUDY OF WIPING CONTACT METHODS.

inductive resistance of German silver wires was prepared to avoid complications from the action of the arc lamp. When this was used as a load for the machine, the throws of the galvanometer changed at once from the erratic behavior observed at first, to the beautifully regular and uniform character now so familiar to all who have used the method under proper conditions.

Fig. 1 is a copy, to scale $\frac{2}{10}$, of the original curves of measurements made Aug. 4. The inner circle gives the angular readings of the circle over which the pointer moved. Deflections of the galvanometer, on discharging the condenser through it, are plotted radially, at the angles at which they are obtained, the heavy circle being taken at zero. The scale is .2 volt per division. Curves *K* and *L* were obtained with the machine connected as in Fig. 2, in which *A* is the armature, *B B* the brushes, *F F* the four field coils, *T T* the terminals of the dynamo, and *R* the non-inductive resistance. The curve *K* gives the deflections obtained when the condenser leads and wiper were joined at *T T*. It will be observed that the curve is symmetrical, giving eight maxima and eight minima per revolution. The minima are below zero, and explain the several deflections observed in the first work on the arc. The resistance *R* being non-inductive, *K* is also the curve of current strength, to a different scale, and shows that the machine was an alternating current machine, although the excess of positive area over negative shows an average positive current. Curve *L* was taken with the machine in the same condition as before, but with the condenser leads attached to the brushes at *B B*. It gives the varying potential of the armature, as modified by the inductive reaction of the field, and shows the same symmetry, with less distortion. For curve *M* the field coils were all thrown on one side of the armature and condenser leads attached at *B B*, as in Fig. 3.

To ascertain the effect of an inductive external resistance on the terminal potentials of the machine normally connected, the connections used in obtaining curve *K* were repeated, the only change made being to insert the six coils of the large Stevens electromagnet with the non-inductive resistance *R*, adjusting *R* to get the same current strength used in getting curve *K*. The resulting curve showed the same characteristics as *K*, but much magnified, deflections ranging from — 300 to + 550. Many other curves were taken, with the machine self-excited and separately excited, on various loads and on open circuit, but the results, though interesting, are not of sufficient importance now to occupy your time. The most interesting curves and results were presented as a joint paper by Prof. Morton and the writer, and read by Prof. Morton before the American Association for the Advancement of Science, at its Boston meeting, Aug. 25–30, 1880. The curves presented and the original records from which they were prepared cannot now be found. Immediately after that meeting the writer entered on his duties at the University of Missouri, and had no opportunity to resume the use of the method until his removal to Ohio in 1885. It was used in that year by his students in an examination of the Thomson-Houston arc dynamo, substituting a Thomson portable electrometer, with Leyden jars to increase its capacity, for the condenser and galvanometer. Since then the method has been used in this laboratory on various apparatus, and in various ways, but it is needless to recount the details.

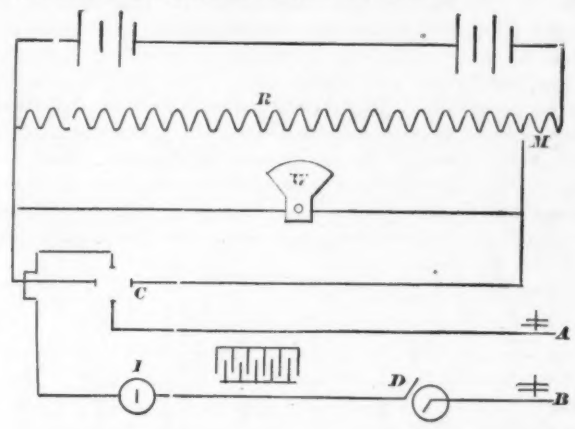


FIG. 4.—A STUDY OF WIPING CONTACT METHODS.

Our experience with the method leads us to prefer the Thomson portable electrometer and Leyden jars to all other instruments for high potential curves. The electrometer is dead beat, is a zero instrument, and is easily and quickly set. As usually made, its constant is from two to three volts per division, and one can easily set to within that amount. The error resulting from an improper reading, say one division wrong, would be of course serious in reading low potentials, but these readings only occur on nearly straight parts of high potential curves, and might be entirely omitted without serious error.

Next to the portable electrometer, we prefer the Thomson electrostatic voltmeters. For low potential curves nothing has yet proven superior to the potentiometer method as used here, and described by the writer at the American Association meeting at Washington last August. The potential difference to be measured is balanced against that produced by a battery in a resistance as in Fig. 4.

In the figure, *R* is a resistance of some convenient form, with which contact may be made with a movable terminal *M*, or which may be varied between or beyond the terminals of the Weston voltmeter *W*. From these terminals wires lead through a commutator *C*, a sensitive galvanometer or telephone *I*, and the wiper *D* to any points *A B*,

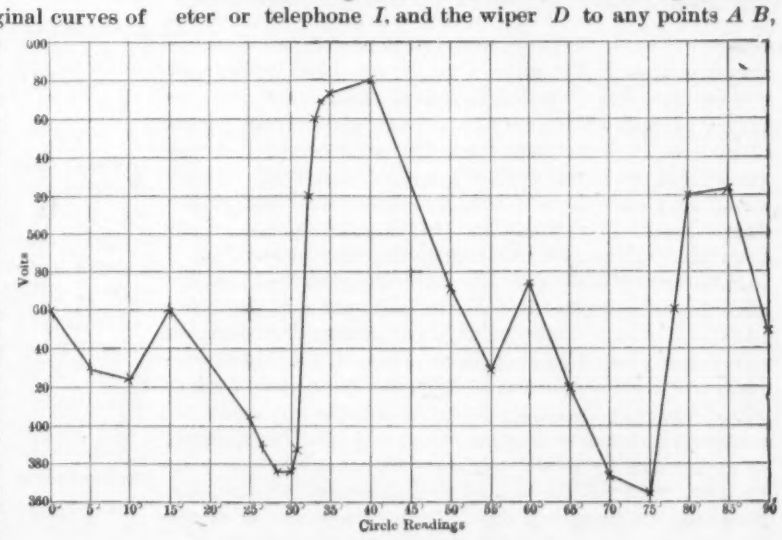


FIG. 5.—A STUDY OF WIPING CONTACT METHODS.

whose potential curve is desired. The whole being in operation, and *C* properly placed, *M* or *R* or both) is adjusted until *I* shows no current, when the potential difference existing at *A B* is read off directly in volts on the voltmeter *W*. The use of the voltmeter and telephone is due to R. D. Mershon, a graduate of the university, who described the method in THE ELECTRICAL WORLD of Aug. 29, 1891.

Fig. 5 is a part of the potential curve recently taken from a Brush open coil motor, run as a dynamo on an inductive load. One-fourth of the complete curve is shown, and the parts not given are quite symmetrical with this. No

* A paper read before the American Institute of Electrical Engineers.

"smoothing" is applied, but the observed points are joined by straight lines. The sharp angular form shown is due to the fact that readings were taken at intervals of five degrees, except between 25 degrees and 35 degrees, where readings were taken at each degree, to determine the character of the sharp variation between 30 degrees and 35 degrees. The change of 130 volts which occurs between 32 degrees and 33 degrees is unique and noteworthy, yet it is perfectly definite and characteristic, and has been repeatedly observed under like conditions. The use of ammeters and voltmeters or galvanometers in power measurements on such machines must, as pointed out in the paper of 1880, lead to incorrect results.

In Dr. Thompson's paper referred to above, reference is made to Joubert's use of the method in 1881, and in the recent edition of Thompson's "Dynamo-Electric Machinery" it is described as Joubert's method. In view of the work here described, and its presentation before the American Association in 1880, it seems proper to claim the method, which in the hands of Professor Ryan, Dr. Duncan and others has led to such valuable results, as an American method.

Efficiency of the Lauffen-Frankfort Power Transmission Plant.

BY CARL HERING.

After a long delay of eight months the results of the official tests of the Lauffen–Frankfort transmission of power plant have at last been made public. Although the final results are not given out at the present time, the most important figures will satisfy many who have continued to be skeptical. The detailed description of the tests, methods and instruments used are to be published later in the official report of the Committee of Experts. But unfortunately, as with most publications of like nature, there appears to be little prospect of this report being published before much of its usefulness is lost. All that is published now is the accompanying table, which though not as complete as engineers would have wished, will at least settle all questions regarding the efficiency of the transmission. The total efficiency of about 74 to 75 per cent. from the turbine shaft to the lamps is certainly a very creditable one.

It should be noticed that in this transmission the current was not re-converted into mechanical power, but was consumed as electrical energy. One of the chief objects of this plant was to show that electrical energy for distribution in cities can be economically transmitted from places at a considerable distance, and it was doubtless for this reason that the motor efficiency was not included. It may be safely assumed, however, that the efficiency of the motor was also very high, and that its introduction in the total efficiency would not diminish this very materially.

For the benefit of those who have not followed the description of this plant it might be said here that the dynamo was wound for generating three alternating currents differing in phase by 120 degrees. Each of the three currents was 1,400 ampères at 50 volts, making a total of about 200 kilowatts. This current was transformed by means of a step-up transformer having a ratio of 1.160. This current, of approximately 13,000 volts, was then transmitted over the line. The voltage in the line is measured between the lines, and not from each line to the neutral point, as in the case of a dynamo. It was stated by a good authority who was present at the tests that the voltage at the time of the measurements was run up to about 16,000. The number of alternations is said to have been 40. The line wires consisted of three bare copper wires, 4 millimetres in diameter, or slightly smaller than a number 6 B. & S. The total distance was 108.6 miles; this represents a resistance of over 200 ohms for each of the three wires.

Detailed and illustrated descriptions of the generator will be found in The Electrical World of Aug. 22 and Oct. 3, 1891; of the motor in the issue of Oct. 3 and Nov. 7; of the plant, Sept. 26; data concerning the cost of the plant will be found in the issue of Jan. 9, 1892. Another article on this subject, though not directly connected with this particular plant, will be found in the issue of Sept. 19, page 193.

The table, which is given out to the public without any accompanying description, is reproduced here in full, together with an additional column in which the writer has given the percentage loss in the line. This table will explain itself and needs no comment. The results were given in order of date, which is the least interesting order into which they could possibly have been put. They here have been rearranged, being given in the order of the amount of power transmitted; the sequence of the columns has also been rearranged. As a mass of figures can never represent the general results in as clear a manner as a graphical picture does, the writer has plotted the results in the accompanying diagrams, the curves of which will show at a glance the real meaning of the figures in the table. It will be seen from these curves that they not only give the results in a nutshell, but they also bring out some points which would not be noticed from the table above.

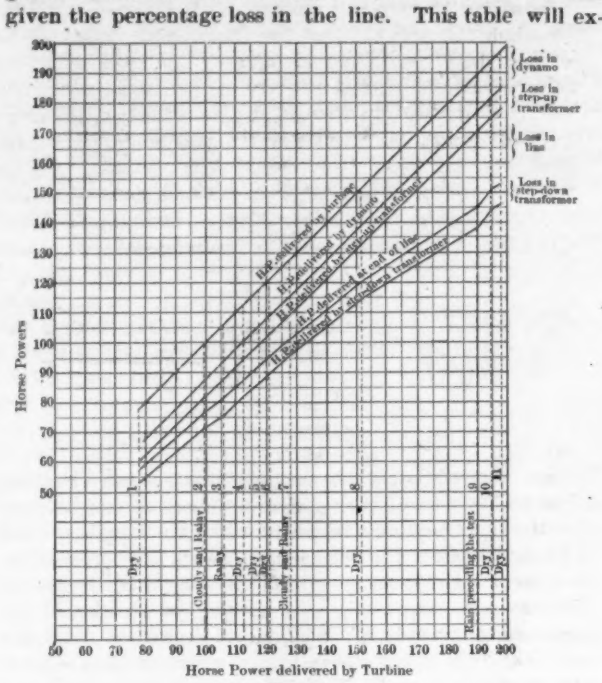


Fig. 1.

Reference number.	Date and time, October. 1891. (Each test lasted 10 minutes.)	Horse-power delivered by turbine.	Horse-power delivered by dynamo.	Horse-power delivered by step-up transformer.	Horse-power delivered to step-down transformer (after transmission).	Horse-power delivered by step-down transformer to lamp.	Loss in line in horse-power.	Loss in line in per cent.	Efficiency of the dynamo, in per cent.	Efficiency of the step-up transformer, in per cent.	Efficiency of the step-down transformer, in per cent.	Total efficiency of the transmission from dynamo terminals to place of consumption, in per cent.	Total efficiency of the transmission from turbine shaft to place of consumption, in per cent.	State of the weather.
1	12th. 2:30 P. M.	78.2	66.1	61.1	58 0	53.5	3.1	5.1	84.5	92.5	92.2	80.9	68.5	Dry.
2	" .. 2:10 P. M.	99.3	86.8	81.5	76.5	71.4	5 0	6.0	87.4	93.9	93.3	82.4	71.9	Cloudy. frequent rains.
3	13th. 9:53 A. M.	105.9	93 3	87.7	81.7	76.3	6.0	6.8	88.1	94.0	93.4	81.6	72 1	Rain till noon.
	" . 10:05 A. M.	105,9	93.3	87.7	81.8	76 4	5.9	6.7	88.1	94.0	93.4	81.7	72.2	
4	" . 1:45 P. M.	112.7	100.1	94.5	87.6	82.2	6.9	7.3	88.8	94.4	93.8	81 9	72.9	Dry.
5	" . 1:30 P. M.	117.6	104.9	99.2	91.7	86.2	7.5	7.5	89.2	94.6	94.0	82.0	73.3	Dry.
6	11th. 1:30 P. M.	120.9	108.1	102.4	95.1	89.5	7.3	7.2	89.4	94.7	94 1	82.6	74.0	Clear, dry.
	" 1:50 P. M.	121.1	108.3	102.6	95.0	89.4	7.6	7.4	89 4	94.7	94.1	82.4	73.8	
7	12th. 1:35 P. M.	127.0	114.4	108 7	100.7	95.1	8.0	7.4	90.0	95.0	94.4	83.0	74:9	Cloudy, frequent rains.
	" . 1:50 P. M	127.5	114.8	109.0	100.9	95.3	8.1	7.5	90.0	95.0	94.4	82 9	74.8	
8	14th. 10:15 A. M.	151.8	139.1	132.8	120.0	114.0	12.8	9.5	91.6	95.5	95.0	81.8	75 1	Dry.
	" . 11:10 A. M.	151.7	139.0	132.7	120.2	114.2	12.5	9.4	91.6	96.1	95.0	82.0	75 3	
9	" . 11:20 A. M.	189.7	177.0	169.9	145.3	138 9	24.6	14.4	93.3	96.0	95 6	78.1	73.2	Rain in the morning.
	" . 11:50 A. M.	190.0	177 3	170.2	145.3	138.9	24.9	14.6	93.3	96.0	95.6	78 1	73.1	
	15th. 10:53 A. M.	190.7	177.9	170.8	145.3	138.9	25.5	14.8*	93.3	96.0	95.6	77.8	72.8	
10	" . 11:35 A. M.	191.7	182.2	175.1	150.7	144.2	24.4	14.0	93.5	96.1	95.7	79.1	74 1	Dry.
11	" . 12:30 P. M.	197.4	184.8	177.6	152.4	145.8	25 2	14.2	93.5	96.1	95.7	78.8	73.9	Dry.

* This includes the small amount of power required for the excitation of the dynamo field.

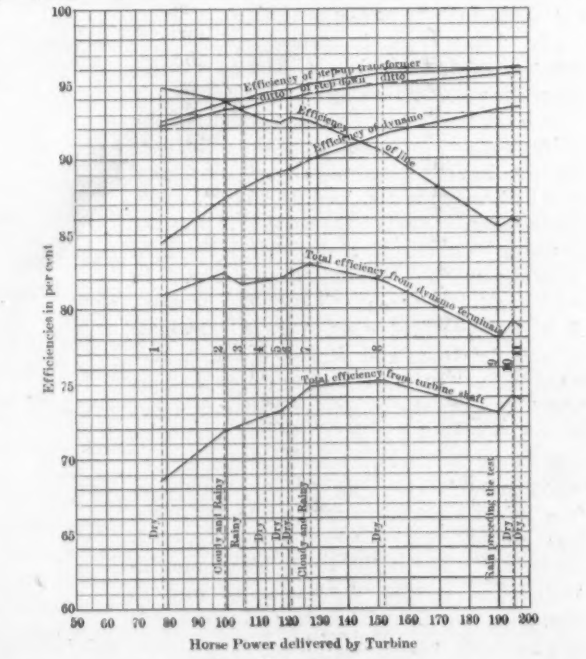


Fig. 2.

In Fig. 1 all the various power measurements have been plotted in such a way that they can hardly be compared with each other, or with the original turbine horse powers, and will show the various losses at a glance. The vertical scale represents horse powers, while the horizontal represents the horse power delivered by the turbine shaft. The latter scale has been made to begin at 50 instead of at zero merely to save room. The diagonal lines represent the powers at the various states of transmission and transformation, and will explain themselves. The vertical distances between the diagonal lines represent the various losses; the vertical dotted lines show the turbine horse powers for which measurements were made; running numbers refer to the data of the table. The state of the weather is given for each test.

The lines representing the input and output of the transformer are also nearly parallel, while those showing the losses in the line are, of course, diverging for larger loads. An interesting feature is the broken nature of the two lower lines at the tests Nos. 3 and 9, especially the latter. It will be seen that these suddenly increasing line losses correspond to some extent with the weather and follow the rain. This appears to indicate that subsequently to a rain the line losses were increased. This is more marked by the fact that these breaks are only on the two lower curves—that is, *below* the line losses, and not above them; the dynamo and step-up transformer would, of course, not be effected by the rain.

It is a pity that further data were not given for the benefit of engineers, showing the losses at very small loads, the static and inductive losses on the line, etc. A few of these losses are indicated by the shape and distance apart of these curves. The curvature of the curve representing the line data may indicate some of the features, but what looks like a line leakage in test No. 9 destroys in a measure the importance which this curvature would otherwise have. The frequency is unfortunately not given. At the time of the exhibition it was stated to the writer to be 40, but others have claimed since then that it could not have been above 20 or 23. Without wishing to deny the latter, the writer thinks that the information given him by the engineers of the plant is to be accepted as correct until we hear differently from them.

In Fig. 2 are plotted all the various efficiencies with the turbine horse powers as the primary power In order to be able to use a larger scale the co-ordinates were started at 50 and 60 respectively, instead of at zero. The line efficiency curve, of course, falls in the opposite direction from that of the others, thus tending in a measure to neutralize them and make the total efficiency curves more nearly a horizontal line. It will also be seen how rapidly the line curve falls with an increase of the load, while the dynamo and transformer curves are still on the increase.

It will be remembered by those who have followed the descriptions of this plant as published in The Electrical World that the line was much smaller than it was intended to be, and that, therefore, the dynamo and transformers were much too large in proportion to the line cross section; the effect of this is shown very plainly by the curves. Were it not for this the total efficiency curves would be more nearly a horizontal line for the important ranges. As it is, the lowest curve is not far from a horizontal line around 74 and 75 per cent.

The peculiar break in the curves mentioned in connection with Fig. 1 for tests 3 and 9 is also seen here on the three lower curves which involve the line efficiency. That for test 9 is more marked in Fig. 2, owing to the larger scale used.

Test No. 9 is the last one which was made, and it is possible that something was wrong with the line at that time, as there was evidently a disproportionately greater line loss during that test, as compared with the loss in the other tests.

The Decision in the Hydrocarbon Lamp Suit.

In the United States Circuit Court at Trenton, N. J., Judge Acheson decided last week the case of the United States Electric Light Company vs. the Edison Lamp Company, involving the right to use the carbon process, in favor of the defendant. A brief note to this effect was published in the last issue of The Electrical World. The salient points in the court's decision, which has since come to hand, are given in the following quotations:

"The suit is brought for infringement of letters patent dated Oct. 21, 1884, and granted to Edward Weston upon application filed May 27, 1881. The nature of the invention is indicated by the claim, which is as follows:

"The improvement in the art of making carbon conductors for incandescent lamps, which consists in first forming a carbon core or base, and then building up said core with carbon obtained and deposited upon the same by and during the operation of electrically heating said core while surrounded by or saturated with a carbonaceous substance, substantially as hereinbefore set forth.

"Of the defenses interposed, it is necessary to consider but two, viz.: First, prior letters patent for the same invention dated January 7, 1879, and granted to William E. Sawyer and Albon Man, upon application filed October 15, 1878; second, the alleged public use of the invention by Sawyer and Man and those acting under them for two years prior to Weston's applications for patent. It is clear that Sawyer and Man's invention is the same as is claimed by Weston; that they perfected it and reduced it to practical use in March, 1878. Notwithstanding this priority, the Patent Office, in an interference proceeding, decided in favor of Weston. This contest was made in 1882, and proofs therein were introduced in evidence in this case.

"Leaving out of view the negative testimony of the defendant's witnesses who would know something of Weston's doings, the plaintiff's own evidence impresses me as sin-

gularly vague. Did his operations amount to anything more than experiment? Could the invention be derived from anything but Quimby or Broadbent (witnesses who testified that they have seen the invention) saw Weston do or learned from him, any more than it could have been deduced from the Despuetz publication of 1849? Does Weston prove that he had a perfect invention in the summer of 1887, as alleged? It is on the all important matter of time that the plaintiff's case rests altogether on recollection. How can Weston's assertion that from about the middle of the year 1877 he saw that he had overcome all troubles relating to the preparation of carbon for incandescent plants be satisfactorily reconciled with his subsequent conduct; his silence as to an invention then deemed so important? His great delay in applying for a patent for the process is more extraordinary when we discover from the proof that in the years 1878 and 1879 he took out and applied for no less than ten patents for various other inventions. Furthermore, it is a significant fact that when Weston eventually moved on May 27, 1881, his application for a patent was made in the interest of the plaintiff company, as assignee, after the plaintiff had failed in its negotiation to purchase the Sawyer and Man patent or to acquire a license under the same.

"To overthrow the prior patents of Sawyer and Man, which were issued as early as Jan. 17, 1879, and immediately followed by uncommon publicity, the proof of anticipation by Weston should be at least positive, unequivocal and convincing. Taking the proofs on the whole, they fail to satisfy me that Weston's alleged invention preceded that of Sawyer and Man. The proofs of the defense of two years' prior public use of the invention before the application of the patent in suit rests on impregnable ground. A public use does not depend upon the number of persons to whom the use is known, and it is enough if a single device embodying the invention is publicly used by even one person. And a public use of the invention more than two years before the application of a patent, although without consent of the inventor, invalidates the patent.

"In March, 1878, when Sawyer and Man made the invention here in controversy, they were engaged in completing an incandescent electric lamp of their own devising, which they patented in June, 1878. Between March, 1878, and May, 1879, they used this carbonating process extensively, and widely exhibited the same. Clearly this use was a public and practical one. Whatever experiments Sawyer and Man may have made after March, 1878, concerning their lamp, with a view of increasing its efficiency and commercial value, the same did not relate to the carbon treatment itself, but was perfected in March, 1878, and required no subsequent test. It makes no difference if the process was not perfect until 1880, and it has been shown that the Sawyer and Man lamp was actually operated and had some practical utility. That it was not a commercial success is not here a controlling consideration. This, indeed, is the position of the plaintiff company, for it alleges that Weston made and perfected the invention as early as the summer of 1877, before a perfectly successful incandescent electric lamp had been devised by any one.

"I have only to add that it is quite evident from the proofs that the issue of a patent to Weston was inadvertently made in disregard of the expressed view of the Examiner of Interference and the Examiners in Chief, that Weston was precluded from the grant of a patent by reason of the statutory bar of two years' public use disclosed by the evidence in the interference proceedings in the Patent Office. For reasons given above and without reference to other alleged defenses, the complaint is dismissed."

The decision, while it releases the Edison Lamp Company from liability under past use of this process, does not necessarily entitle it or any other manufacturer other than the plaintiff, the United States Electric Lighting Company, to use the same without liability for damage.

Some Incandescent Lamp Curves and Some Wire Calculations Without Tables or Diagrams.

BY PROF. E. P. ROBERTS.

The accompanying curves seemed of interest to many at the recent meeting of the Institute of Electrical Engineers. Probably this was because of the range covered, as nothing new is shown. The writer willingly accedes to the editor's request to be allowed to publish them, as the more information the lamp user obtains respecting the lamp the better it is for electric lighting in general, and the lamp manufacturer in particular. The wiring calculations may prove of value to some one who has left his note book at home.

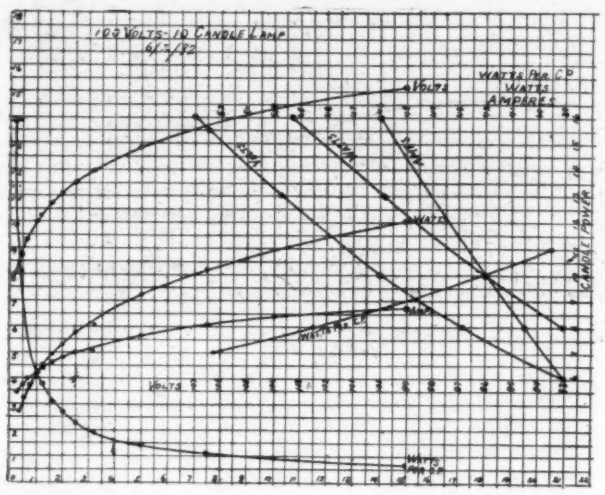


FIG. 1.—Main Curves: C. P., 10-1; Volts, 10 1; Ampères, 10-1; Watts, 10-1; Watts per c. p., 1-10.

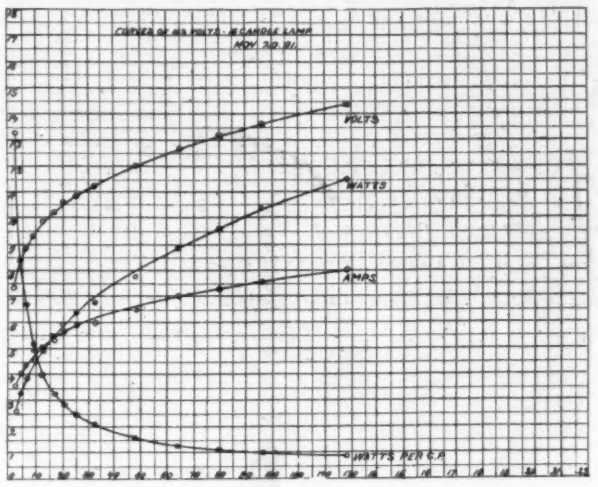


FIG. 3.—C. P., 10-1; Volts, 10-1; Ampères, 1-10; Watts, 10-1; Watts per c. p., 1-10.

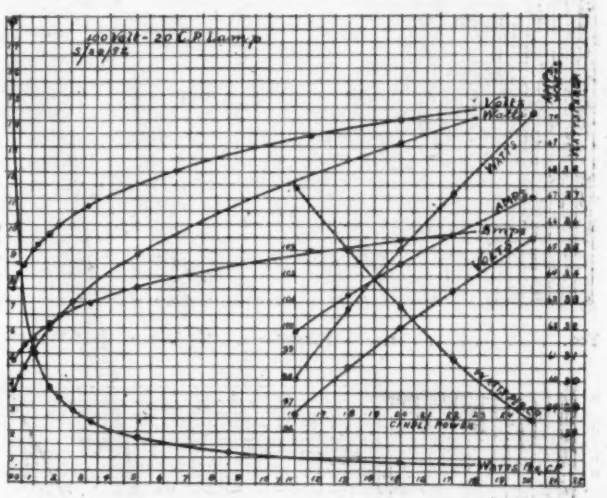


FIG. 5.—C. P., 10-1; Volts, 10-1; Ampères, 1-10; Watts, 10-1; Watts per c. p., 1-10.

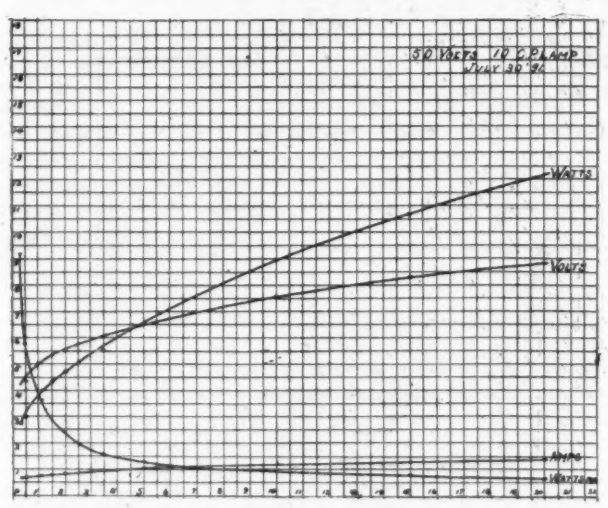


FIG. 2.—C. P., 10-1; Volts, 10 1; Ampères, 1-10; Watts, 10-1; Watts, 10-1; Watts per c. p., 1-10.

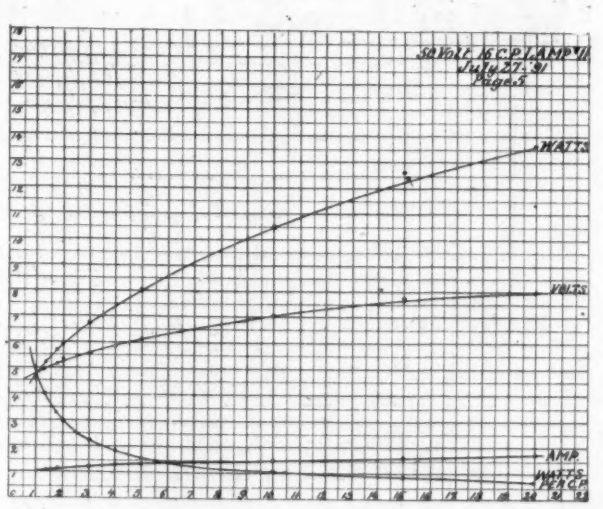


FIG. 4.—C. P., 10-1; Volts, 10-1; Ampères, 1-1; Watts, 10-1; Watts per c. p., 1-10.

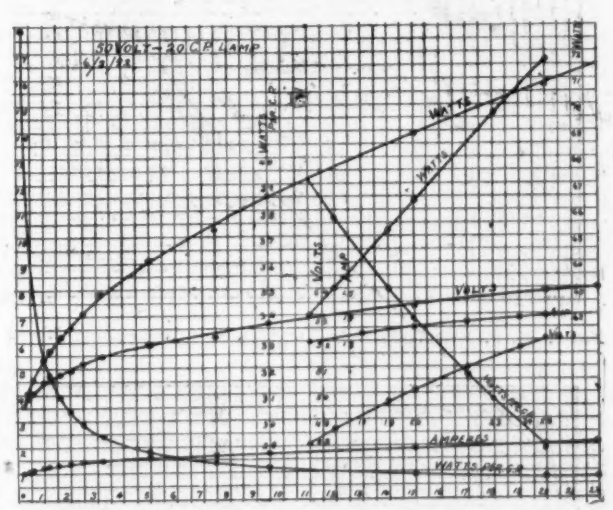


FIG. 6.—C. P., 10-1; Nolts, 10-1; Ampères, 1-1; Watts, 10-1; Watts per c. p., 1-10.

FIGS. 1 TO 6.—LAMP CURVES SHOWING THE INTER-RELATION OF VOLTAGE, CURRENT, WATTS AND WATTS PER CANDLE POWER.

I. INCANDESCENT LAMP CURVES.

The curves show the inter-relation of voltage, current, watts and watts per candle power, over a considerable range, for lamps of from 10 to 50 c. p. and of 50 and 100 volt standards. The candle power is plotted horizontally—the scale being 10–1 of the figures marked, each division representing five candle power. The vertical scale varies according to convenience in any lamp considered and is marked accordingly. Some of the figures have the portion relating to the lamp at and near its normal candle power enlarged to a scale ten times that of the main curves. This makes it easier to read over the part most often used. The candle power is measured at 45 degrees to the plane of the carbon, and is practically the mean horizontal candle power

For a curve giving the effect of a variation of voltage on the life of an incandescent lamp the reader is referred to a recent paper by the writer entitled "The Lamp, the Electric Light Station Manager and the Customer."* Prof. Thomas' paper at the Chicago meeting of the Institute of Electrical Engineers shows the general character of the drop in candle power during life.

The great fact relative to the incandescent lamp, for the average station man to consider, is the shortening of life by a comparatively slight increase of voltage. Constant potential at the lamp is impracticable. A total variation of not over four per cent. is better than the average. Ten per cent. is not rare, 20 per cent. and more not unknown, and as a three per cent. increase cuts the life to about one-half and six per cent. to one-fifth it is submitted that one of the best means to declare dividends is to cut down the lamp renewals by careful planning and, after erecting, by checking the system of wiring, and by careful station regulation of feeder potential, lowering the potential at the feeder ends when necessary, to obtain constant potential difference at the lamps. Care in this matter results in giving not only longer life to the lamps but better satisfaction, because when a customer once sees a 16 c. p. lamp burning at 25 c. p. he is not satisfied unless such brilliancy is maintained. The writer recently inspected a large isolated plant of 2,500 or more lights where the man in charge (an "expert") stated with pride that he kept his dynamo potential constant through the 24 hours. Fortunately the wiring was for five per cent less, so he only had a possibility of straining the lamps on light load something very little less than five per cent., on some circuits almost nothing less. Examples might be multiplied sufficient, even when condensed, to fill a quarto edition.

Fig. 12 is a diagram which is useful when considering lamps and also for other purposes. The first vertical column gives candle power, the second the total watts taken as the standard for such candle power, the third the watts per candle power for such a standard, and the fourth column total watts. In order to obtain the ampères corresponding to any total watts for any desired voltage, the line indicating the total watts is followed horizontally until intersection is made with the vertical line indicating the desired voltage and the diagonal line intersecting at such point gives the ampères. Heavy lines are drawn through 55 watts (the standard taken for 16 c. p., and 50 and 100 volts. Of course the total watts for a given candle-power will often not be in accordance with the standard shown, 16 c. p. lamps being ordered of from 50 to 66 watts.

Example No. 1.—Given a 54 volt, 55 watt lamp, what current will it take? Follow the 55 watt line to 54 volts. The diagonal is almost half way between 1 and 1.05.

Answer.—1.02 ampères.

Example No. 2.—Lamp (at candle power desired) 110 volts, .85 ampère. Find the total watts.

Answer.—Intersection of .85 ampère and 110 volt lines gives 93 5 watts.

II. LAMP AND WIRE CALCULATIONS WITHOUT TABLES OR DIAGRAMS.

1. To determine the resistance of the lamps when candle power and voltage are known.

2. Given the percentage of loss to be allowed in the line, to ascertain the line resistance.

3. Given the line resistance to determine the size of wire, weight, etc.

1. Evidently if the total candle power and watts per candle power be known the total watts is their product. The current equals the total watts divided by the voltage. The resistance of the lamp equals the potential difference (at the lamp) divided by the current. All that is needed is to apply Ohm's law.

$$\left.\begin{array}{l}\text{Total candle power} = a \\ \text{Watts per candle power} = b\end{array}\right\} \text{total watts} = a\,b.$$

* See THE ELECTRICAL WORLD of March 19, 1892.

Potential difference at lamp = V therefore current (C) = $\frac{a\,b}{V}$

Lamp $R = \frac{V}{C} = \frac{C \times V}{a\,b}$

Example.—Given 200 16 c. p., 3.4 watts per candle power, 100 volt lamps, to find the C and R.

Answer.—$C = \frac{200 \times 16 \times 3.4}{100} = 108.8$ ampères.

$$R = \frac{100}{108.8} = .92 \text{ ohm.}$$

2. This is evidently a matter of percentage. In the example above if 10 per cent. of the total energy given to the line is to be allowed for line loss, and the loss is to be calculated on the basis of 200 in use (probably 250 or 300 connected), then the line resistance will be $\frac{.92 \times 100}{90} \times .1 = .102$ ohm.

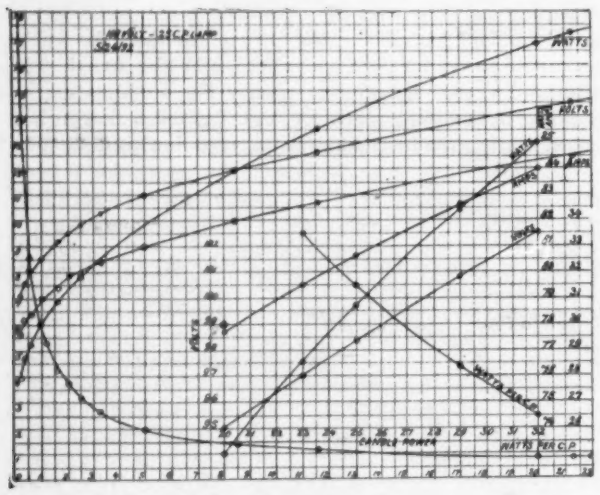


FIG. 7.—C. P., 10-1; Volts, 10-1: Ampères, 1-10; Watts, 10-1; Watts per c. p., 1-10,

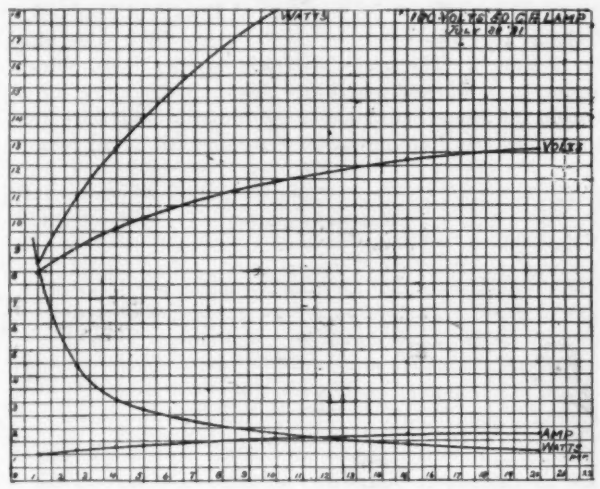


FIG. 10.—C. P., 10-1; Volts, 10-1; Ampères, 1-1; Watts, 10-1: Watts per c. p., 1-10.

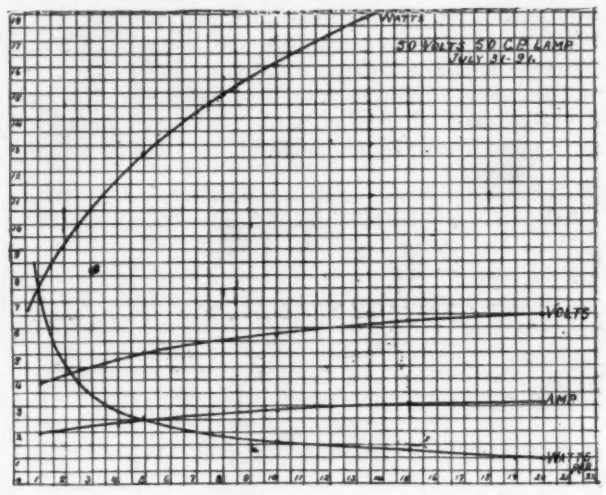


FIG. 11.—C. P., 10-1; Volts, 10-1; Ampères, 1-1; Watts, 10-1; Watts per c. p., 1-10.

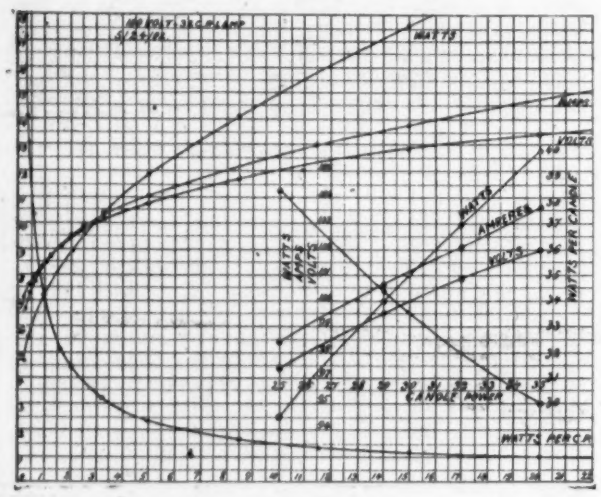


FIG. 8.—C. P., 10-1: Volts, 10-1; Ampères, 1-10; Watts, 10-1; Watts per c. p., 1-10.

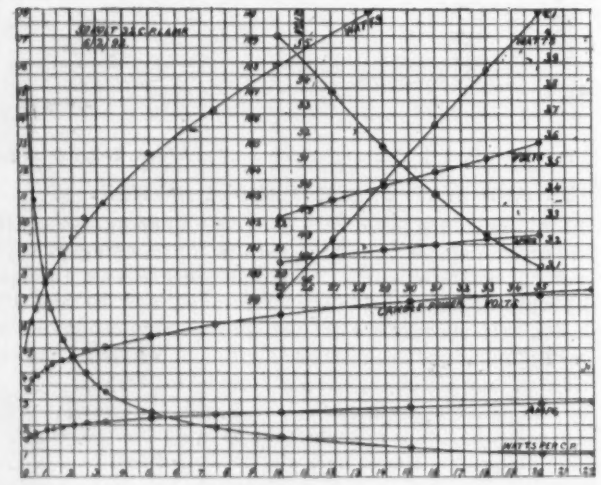


FIG. 9.—C. P., 10-1; Volts, 10-1; Ampères, 1-1; Watts, 10-1; Watts per c. p., 1-10.

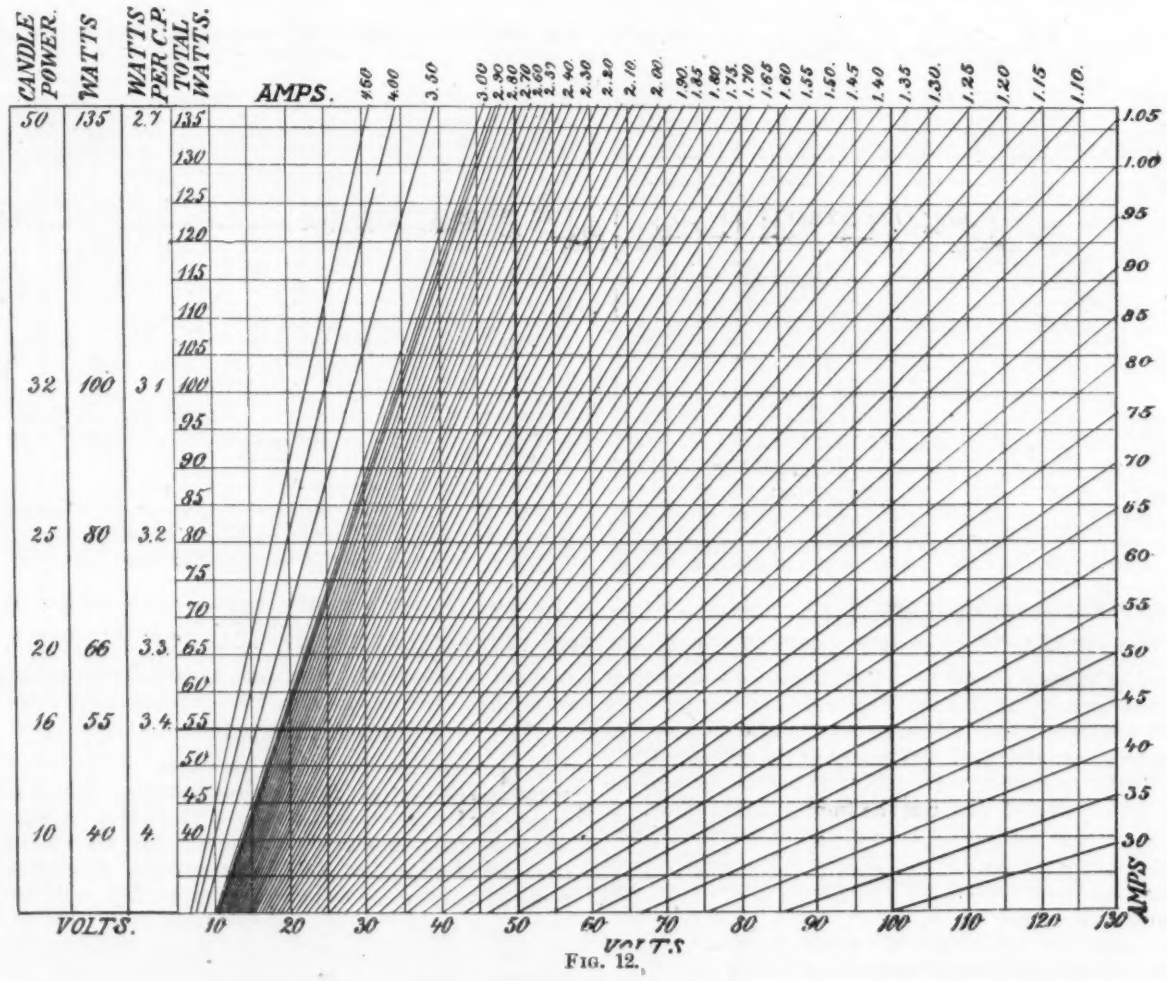


FIG. 12.

FIGS. 7 TO 12.—LAMP CURVES SHOWING THE INTER-RELATION OF VOLTAGE, CURRENT, WATTS AND WATTS PER CANDLE POWER.

If the line considered be 800 feet total length then the resistance per thousand feet is the resistance of 800 feet + the resistance of $\frac{1}{4}$ of 800 feet = .102 + .025 = .127 or, taken as an example in percentage, $\frac{.102}{80} \times 100$.

3. The next point is to determine the size of wire, its weight, &c. The writer noted the following when studying the matter of wire gauges—presumably, almost certainly, some one has published it—but as the writer has not seen attention called to it, or been able after considerable inquiry to find any who have, he lets it go to print.

(a) The B. & S. gauge is based upon the law of geometrical progression.

(b) No. 10 B. & S. gauge wire is .1 inch in diameter and measures one ohm per thousand feet.

The factor connecting the area of cross section, and consequently the resistance and weight, of one size of wire with the size next on the scale is $\frac{1}{4}$ or $1\frac{1}{4}$, according to whether ascending or descending. Therefore the resistance of any wire smaller than No. 10 is $1\frac{1}{4}$ (1.25) raised to a power equal to the difference between No. 10 and the size desired, and the resistance of any size smaller is $\frac{1}{4}$ (.8) treated in the same way. For example: No. 10 wire = $1\frac{1}{4}$ to the fourth power = 2.44 ohms per thousand feet. According to the table the resistance of 14 = 2.53. The discrepancy is due to using 1.25 instead of 1.26 (the correct figure) and to the gauge not strictly following the law. To take an application to a larger size, consider No. 6. The difference 10 — 6 = 4; therefore, 8 to the fourth power = .409 — tabulated resistance = .395, evidently practically accurate. Whatever allowance deemed advisable can be made for conductivity—usually it will be a matter of nearest size without considering 2 or 3 per cent. loss due to 97 or 98 per cent. conductivity. If it so happen that a table of logarithms be accessible then calculations are assisted by noting that, as the resistance of No. 10 wire is one ohm per thousand feet its logarithm = 0, and that the logarithm increases by .1 for each number higher than 10 and decreases by .1 for each number smaller. If therefore the resistance of No. 5 wire be desired, the logarithm of the resistance will be 0 less .5 = 1.5 resistance = .317 ohms per thousand feet. If the wire be No. 18 the logarithm will be 0 + .8 giving 6.31 ohms.

Evidently an order could now be sent to "Express at once — feet No. — wire," but possibly the investigation involves a question of weight. The weight of No. 10 wire is 31.37 pounds per 1,000 feet (approximately $33\frac{1}{3}$ per cent. or $\frac{1}{3}$). It is perhaps easier to remember that No. 5 weighs 100 pounds per 1,000 feet. If preferred, an effort can be made to remember that one cubic foot of copper weighs 555 pounds, or that one mil-foot weighs .003 pound. As the diameter of No. 10 wire is .1 inch, and as the resistance is inversely proportional to the area, or weight, it is evident that weight can be readily calculated. For most sizes of wire used in aerial work the insulation weighs approximately 20 per cent. of the total, and therefore 25 per cent. must be added to the weight calculated for bare wire. Then by adding three per cent. to five per cent. for slack and error in measurements, and an additional percentage if the size be but No. 10 or near thereto (see table at end of article), the investigator is in a condition to telegraph for the pounds required, or to make an estimate of cost of wire, That is, provided he can remember:

1. Ohm's law and can use it. 2. That lamps are made of from 3 to 4 watts per candle power—safe average, 3 to 5; 3. That No. 10 wire measures 1 ohm per thousand feet, and is .1 inch in diameter and weighs about 33 pounds per thousand feet. 4. The $\frac{1}{4}$ or $1\frac{1}{4}$ ratio law of the B. & S. gauge.

The question of carrying capacity seldom enters lamp wiring calculations, as wire large enough for the drop is usually safe to use. No. 10 will carry safely 20 ampères and other sizes, between the limits used for aerial lines, about in proportion to cross section; small sizes will carry more in proportion than large ones, but it is well not to approach the limit in any case, especially for interior work, because of safety in fusing.

Of course, any man who neglects to use tables, curves, slide rules and other conveniences of a like nature when they are accessible is nothing less than a fool, but sometimes it will happen that a calculation is desirable and the usual conveniences not obtainable. In such cases a knowledge of principles is essential, and if to the same be added a few fundamental constants, there will almost surely come a time when the trouble taken to add to one's stock of permanent and personal information will be far more than repaid.

B. S. G.	R. of Pure Copper.	R. obtained by raising 1¼ or ⅘ to power.	Per cent of Error.	R. by Log Tables.
2	.156	.167	7 per cent	.158
4	.249	.262	5 " "	.251
6	.395	.409	3.5 " "	.398
8	.629	.64	1.7 " "	.631
10	1.	1.	..	1.
12	1.590	1.56	1.9 " "	1.585
14	2 591	2.44	5.8 " "	2.512
16	4.019	3.79	6 " "	3.982

Insulation.*

BY THOMAS A. EDISON.

To telegraphy the insulation of its circuits is so vital a matter that, at the risk of making history repeat itself, and of recounting an oft-told tale, a short paper on the subject may be tolerated.

As a class, gases are the best insulators; next liquids, and solids last of all. The insulation of gases is so good that no determination appears yet to have been made of any leakage through them. If it were possible to make an experiment at or near the centre of the earth, so as to be beyond the reach of gravitational force, an electrified body might be left for hours in a gas without any visible means of support, and observations then made to determine whether any loss of charge took place through surounding gases. Under existing circumstances the loss of charge which always does take place on electrified bodies cannot readily be traced beyond that through the suspension or support that holds them. Even in moist air the loss of charge has not yet been brought home to the aqueous vapor. Prof. Boys exhibited before the Physical Society of London, in April, 1889, a pair of electrified gold leaves, suspended in moist air by a short hook of quartz. The loss of charge appeared to be about 25 per cent. in five hours. A glass hook under the same conditions would have allowed the charge to disappear, it is said, within one minute.

If any perfectly insulating solid could he found, telegraphists would soon discover any surface leakage from their wires through the air, for the surface of a No. 8 B. & S. wire is 224 square feet, or 20.8 square metres per mile.

The loss of charge which takes place convectively into the air over any sharp point in an electrified body is a phenomenon of a different nature. There, the layer of atmosphere over the point is continually being torn by the magnitude of the forces brought locally to bear upon it, and the particles of moving air carry away the charge.

Some liquids have also a very high insulation, notably most mineral oils. Animal and vegetable oils are by no means so good, or at least there is greater difficulty in obtaining them in a highly insulating condition. Water, contrary to prevailing notions, is quite an insulator. In the purest distilled water, resistance as high as 7 megohms per c. c. have been recorded; that is to say, a block one centimetre cube of water pressed between two opposite conducting planes as electrodes would offer a resistance of 7 megohms; but the least trace of impurity brings the resistance down.

Ice at 12 degrees C. has been measured at 2,240 megohms per cubic centimetre. There are two conditions of surface upon which bare wires, miles in length, laid on the ground, have been worked telegraphically, one over the dry desert sands of Africa, the other over dry ice in the far north. Sea water has a resistance of about 30 ohms per c.c. at 4 degrees C.

It would appear probable that liquids cannot conduct without electrolytic decomposition. A microscope will show that one microampère decomposes the drop of water it traverses.

One of the most important and promising modern theories of chemistry is based upon the assumption, in accordance with a considerable array of facts, that solutions only conduct by the transfer of atoms or ions to the electrodes, each carrying an electric charge, and the conductivity of a liquid measures, on this hypothesis, the number of uncombined or dissociated ions permeating its mass. These free ions are the porters carrying the charge, and the conductivity of the liquid depends upon the number available and the speed with which they can migrate.

Liquids, too, have, as a class, the quality of elastic insulation to high tensions, which is an important feature to the electrical engineer. Air for the first few centimetres will break and allow a spark discharge to occur when the pressure reaches from 10,000 to 50,000 volts per centimetre (25,400 to 127,000 volts per inch), according to the shape and condition of the electrodes, but the rosin oil is said to stand about 75 times the pressure of air per centimetre without disrupting.

The following is a list of actually observed resistance in commercial samples of well known insulating substances. The results are given in megohms per cubic centimeter at or near 18 degrees C.

Paraffine wax, 110,000,000 megohms; heavy paraffine oil, 8,000,000 megohms; olive oil, 1,000,000 megohms; lard oil, 350,000 megohms; creosote, 5.4 megohms; stearic acid, 350,000,000 megohms; sperm oil, 0.077 megohm; benzine, 14,400,000 megohms; balsam copaiva, 211,000 megohms; benzole, 1,320 megohms; oil of wood tar, 1,670,000,000 megohms; crude ozokerite, 450,000,000 megohms.

All transparent solids are insulators, but of course the opposite statement is not true that all opaque solids are good conductors. There is now good evidence for believing that the process by which light is propagated, the mechanism by which it is transmitted through space, is purely electromagnetic, and the magnetic vibrations passing through a conductor would generate electrical currents and be absorbed in the substance as heat, that is to say, it would be opaque to the light, failing to transmit the energy.

The difficulty with solids is not so much to find insulators, for the great majority of solid substances freed from moisture are poor conductors, but to find an insulation of suitable mechanical qualities. Glass, porcelain and mica seem to be almost the only practically available insulators that will support considerable stresses, and these for many structural purposes are far weaker than is desired. In American telegraphy glass is almost the universal insulator, but in Europe, particularly in the South and West, the atmosphere is so much more humid, and glass so hygroscopic, that no circuit of any length could be operated with glass insulators except in dry weather. Porcelain or vitrified stone-ware insulators are used instead, and in quite a variety of forms. Practically speaking, the insulation of a line is never that of the material forming the insulators, but always that of their surfaces, and the films of dust and moisture that may have become incrusted thereon. The most perfect insulators are those which have underneath the hood a cup filled with oil, in such a manner that the current leaking from the wire to the ground has to pass over the oil, or else through the substance of the insulator itself. These insulators are certainly more expensive, and require to be refilled with oil at intervals, but they will defy weather and keep the insulation nearly as high in fog as in sunshine.

When a long, leaky wire is opened at the distant end, and tested for insulation, the insulation per mile always appears to be somewhat more than it is for any actual mile, since the more distant portions of the line are tested with a reduced pressure, owing to the leakage over the nearer portion. When the wire is grounded at the far end, and its conductor resistance measured, the leakage will, on the other hand, make the apparent resistance per mile too low. But if the conductor resistance is reduced in a given ratio, say as 100 to 95, the insulation will be overindicated in the exact inverse ratio of 95 to 100, provided that the insulation of the line is uniform. So that if a wire's conductor resistance at its temperature of observation is known to be 10 ohms per mile, but appears by leakage over the whole length to be 9 ohms, then if the insulation per mile apparently measures 400,000 ohms, it will be really 360,000, and each mile taken separately might be expected to measure 360,000. As is well known, telegraph lines work better up to a certain point if the insulation is rather low. A wire has to be emptied of its charge between the impulses of the key sufficiently far to keep the relays from sticking. If the insulation is perfect, this quantity has to be cleared through the ends to the ground, but if the line leaks it can escape more readily at all points.

The longer the line, the more essential good insulation necessarily becomes. The insulators are perhaps never more carefully tested than those intended for the long circuits on the Asiatic plains. It was at one time customary to test each insulator before it went out, by taste. The insulator was immersed nearly to the rim, head downward in water, and a battery of 100 cells was connected with one pole to the water and the other to the insulator stalk through a particular kind of key. The operator first rested his moistened finger on this key and then applied his tongue to it. If he tasted no current, the insulator was passed out as satisfactory. The test was sensitive and expeditious, and saved the care and handling of a galvanometer.

The insulation of a wire is a definite term and stands for a definite property so long as it is not necessary to measure is very accurately. There is usually no difficulty in finding the insulation of any overhead wire within 5 per cent. at any one time, and two observers measuring the line from the same end with different instruments would generally agree in their results to that limit, but as higher degrees of accuracy are attempted (a condition that fortunately does not practically occur), the difficulty of obtaining concordant results may increase rapidly. A resistance coil of wire at a uniform temperature can have its resistance measured to within one-fiftieth of one per cent., if necessary, but a leakage resistance is essentially liable to variation. The atmospheric conditions may be altering, or there may be polarization, or inductive disturbances from neighboring wires, or a combination of conditions that may set close measurement at defiance. It is generally advisable to employ galvanometers for this purpose that even if sensitive are slow of movement and dead-beat.

The only instances in which accurate measurements of insulation are possible and necessary, are in connection with subterranean or sub-aqueous wires. Jute and paper, dry or saturated with compound, are rapidly coming into use for subterranean wires sheathed in lead, while for long cables under water india-rubber and gutta-percha are invariably employed. With conductors highly insulated by these methods, the insulation can be measured much more closely, and is definite for a given temperature of the core, but even in this case the current that will flow from a battery into the wire freed at the distant end is not all leakage. A considerable portion may be stored up in the insulating substance, and be returned from the wire to ground after the battery has been removed. This "polarization" is particularly noticeable with gutta-percha and india-rubber covered wires, and their insulation may be apparently 50 per cent. greater after three minutes of charging than at the end of the first minute. In specifications it is usual to call for a certain insulation per mile at 75 degrees C., and after a definite interval of charge.

The insulation obtained from a given thickness of covering depends on the diameter of the wire as well as on the quality of the cover, for a large wire supplies a larger leaking surface. Also if an insulating coating of a certain thickness produces an insulation of 100 megohms per mile, doubling that thickness will not double the insulation because the leakage will take place with greater relative facility through the greater surface of the second coat. The exact increase of insulation will depend upon the diameters of the first coating and of the wire.

When a wire is well and homogeneously insulated, its insulation resistance at a given duration of charge or period of electrification will appear to be the same with different battery powers or voltage applied, but if on the contrary it contains any small faults or defects, it will generally show less insulation with increasing testing pressures. This often forms a criterion as to the reliable insulation of a long cable. The insulation in an ocean cable under the pressure of great depth and near the temperature of melting ice that deep oceans approach, might be 15,000 megohms per nautical mile at the fifth minute. With a small incipient fault the insulation might still reach 3,000 megohms per mile and seem excellent, but it is probable that when tested with 5 cells and with 50 cells, the insulation resistance in the latter case would not appear so high. It would also probably be different with the zinc or copper pole to line.

The only value that can attach to a high measured insulation is the assurance it conveys that no flaws exist in its covering or supports, and will therefore remain in good signaling order unless disturbed. In fact, a very high insulation, as we have seen, actually tends to retard signaling. Mechanical security from the loss of insulation is the great desideratum rather than a very high degree of insulation itself.

* A paper read at the eleventh annual meeting of the Railway Telegraph Superintendents, at Denver.

Individual Selection of Electrical Objects.*

BY S. S. BOGART.

Individual selection, as applied to electrical objects, has some interesting features. It is strikingly singular that it has not received more attention at the hands of the eminent persons here present. The application of a selector to any circuit to reach any of the objects desired, and the necessity for such a device, is doubtless as apparent to you all as is the application of the current to telegraph, lighting and power. In the individual call-bell circuit we have a combination of electrical impulses on a transmitter (or sent by an ordinary Morse key) and selector shaft that correspond with each other. Any other than the combination for that instrument throws in a false combination, upsets the pawls and restores the selector's sector to zero. This principle applied to all the other selectors on the circuit acts in a like manner. The call-bell set consists of a key, transmitter, relay-sounder, answer back and bell. When the combination has properly completed its phase the answer back is vitalized and it automatically transmits the assurance back over the wire that the object has been reached and the bell is ringing. The sounder is always in circuit, except when the bell is ringing, then all of the battery is transferred to the bell. But three cells of ordinary Callaud or gravity battery are necessary for the entire circuit. There are no short circuits always a magnet's resistance interposed, consequently the battery is in a normal condition, does not waste under local action or wear out through short circuiting. The advantages of this system in saving time in calling offices have been carefully gone over, and as it is an undisputed fact that upward of one-third of the time is spent in calling, the fact is apparent that the general managers will bless us all for not asking them to build additional expensive wires on which we are to spend one-third of the time calling the offices. The greater the number of wires the more difficult the problem of raising the one or two operators at some points. As we increase the number of wires on the poles, we increase the crossfire or induction and escape. When the relay adjustments change to such an extent as to affect the sounder, the selector will work so long as the armature of the relay moves to its contacts. Other arguments too exhaustive to advance here could be offered in favor of the adoption of such a system. Fearing that they might smack too strongly of bias in favor of my own, I prefer to have my associates set the bias from another direction.

For Electric Light and Power Use.—In connection with the use of arc lights the selector system affords a simple and effectual means of starting and extinguishing lights at various hours upon the same circuit. Arc service, as is well known, is usually run on "day," "nine o'clock," "midnight," "all-night" and other circuits, and frequently all these may be found on one block or street. This multiplicity of circuits and variety of uses lead inevitably to greater expense, increased risk and difficulty of operation. The application of the "combination" device permits the several classes of lights to be operated on one circuit and the central offices to control each separate class, or each group in that class, as desired. Incandescent circuits and those used for the transmission of power are equally subject to the control of the "combination selector," and in all branches of lighting and power work the system may be applied to advantage. The automatic attachment both insures safety of operation and announces to the transmitting point the completion of the desired work, while the economy resulting from its use on circuits of wide extent of great activity will be an important consideration to every company employing electric lights or power.

For Fire Alarm and Police Service.—The use of these instruments on the police and fire circuits of cities enables an alarm to be confined to such posts or stations as are at the moment required, instead of arousing the entire department, as is generally the case. The call may be limited to a single station, or to a group of them, or to a whole district according to the "combinations" employed. The immense saving of time, money and fatigue to men and horses by the adoption of such an individual signal will be readily appreciated by all familar with the present system in vogue in our departments of public safety. The chief of a department can direct his summons at pleasure to the stations he wishes to reach, and by using a number of combinations can employ as many different signals as necessity requires.

For Telegraph and Telephone Purposes.—In "village and town" telephone exchanges and upon long distance and all private lines the application of these selectors will insure complete privacy by the exclusion of all intermediate telephones. In circuits of minor importance the central office may be entirely dispensed with, each subscriber being supplied with his own combination and those of the others upon the same circuit. This system permits calls to pass noiselessly through intermediate telephones, thus avoiding the vexatious ringing of all bells which now occur when one subscriber sends a signal to another. The fact that no message will be audible to any subscriber other than the one immediately interested opens what is practically a new field for the development of the telephone.

For Naval and Military Purposes.—While for obvious reasons it is not convenient to discuss in detail the use to which this system is now applied in connection with military and other government service, it may be pointed out that it (1) gives at any moment to headquarters or other proper authority the control of the line; (2) allows confidential intercourse between any two points on a circuit without including intermediate stations; (3) gives to the commander of a battery of guns or torpedoes the faculty of discharging at will any one weapon upon a circuit without danger of affecting the others, thus dispensing with the necessity of having a separate wire for each individual weapon; (4) places

* A paper read at the eleventh annual meeting of the Railway Telegraph Superintendents, Denver, Colo.

in the hands of headquarters or its delegates the exclusive power of affecting any electrical circuit, by giving them the means of changing the combinations of the various stations at pleasure, by which no station can be actuated except by one familiar with the respective "combination."

A more recent connection and one that is received with marked favor by leading railroad men is its application to the Leonard interlocking block signal and the Leonard train order signal. In the former it enables us to use a wire for other than blocking trains, thus saving a duplication of wires. In the latter the train dispatcher is master of the situation, and controls as many signals as he desires from his table, and receives assurance of the fact from the return signal that the object sought has been attained.

Its application is daily finding new fields. I will not weary you with more detail. The fundamental principle is accomplished. All that we have now to do is, simplify and educate the electrical brotherhood that the individual selector is an established fact.

The Block Signals of the Present, and What Is Required for the Future.*

BY J. B. STEWART.

A great deal has been written on this subject during the past year; railroad officers have given more attention to it than ever before and the American Railway Association (formerly called the General Time Convention) has appointed a committee to consider and recommend a standard block signal system, involving, as it does, the very safeguard to the reputation of any railroad that attempts to meet the demands of the traveling public for high speed and safe transportation.

The English or Sykes system is the one now generally in use. Does it meet the requirements and give the necessary security? To answer this question let us first give briefly the method of protecting trains by this system, with which doubtless a great many of you are already familiar.

Each office is supplied with a semaphore signal; the lever controlling the arm is locked, and an operator desiring to give a signal to an approaching train must ask the operator in advance to unlock his lever; the signals between block stations are given by a bell code on some roads, and on others where the locking arrangement is not used by the regular Morse code. As soon as the train passes into the next block, the operator places his signal to indicate danger, the lever being again locked. He then signals the operator in the rear that the train has passed out of the block. On crowded roadways, and especially where trains are "closing up" on approaching the great terminal points, these signals must be given instantly, so as not to detain the following train. Herein lies a very great danger. This was brought more forcibly to my mind by reading the very able article written by Mr. Theo. N. Ely, General Superintendent of Motive Power of the Pennsylvania Railroad, and published in *Scribner's Magazine* for March, on the subject of train speed. Mr. Ely claims that "speed at the rate of one hundred miles an hour is no longer a question of motive power, but one of transportation facilities and methods," and, after calling for a perfect roadbed, "the alignment almost free from curvature, etc.," he says, "one hundred miles per hour is made possible, but only upon the fulfillment of one other condition, namely, a *clear track* ahead." All talk on the question of such a high rate of speed may appear to be based on theory, but let us consider for a moment our "limited" trains of to-day are scheduled at an average of about 53 miles per hour, which, of course, includes all stops; adding the time thus lost to that which is lost in climbing heavy grades, running slowly through cities, towns, etc., these trains must maintain an average of more than 60 miles per hour and this means 75 and 80 miles per hour on the best running grounds. And, further, the high speed of our fast freight trains and the distance covered by such trains after the brakes have been applied for an emergency stop will, I think, convince all of you that we are surely and rapidly advancing to the high limit now set and that our block signals have not kept pace with it.

This brings up the question how soon after receiving warning of danger a train running at this speed can be stopped. Accepting the figures given by Mr. Ely (for I am sure we recognize in him a competent authority), it is estimated that a train running at the rate of 60 miles per hour with full braking weight of the train and rails in the most favorable condition could be brought to a full stop in 900 feet; at 80 miles per hour in 1,600 feet; at 90 miles in 2,025 feet and finally at 100 miles per hour in 2,500 feet.

You will observe that these figures are based upon the most favorable conditions, but such conditions cannot be relied upon. Starting a train, either passenger or freight, from Buffalo, with every part in perfect order and the weather clear, the load may be heavier on one day than on another, making it harder to stop, and before that train reaches New York the brake shoes are worn, the leverage is strained and pulls unevenly, the track is wet and slippery along the Hudson, and the fog obscures the signal until the train is very close to it. Should we not then base our figures on the most unfavorable conditions and, again quoting Mr. Ely, ask "that the train receive its warning at least three-quarters of a mile before it must halt?" Now, coming back to the point of danger, the operator has "cleared" his block, but the train has only gone 1,000 feet into the next block, and, from some cause, has stopped. Before this is discovered the fast train following has been given a clear signal at the station in the rear and covers the 4,000 feet between the two signal stations in about 27 seconds, there the engineer finds the signal in danger position and applies the brakes, but according to Mr. Ely's figures the momentum and weight of that train will carry it at least 1,500 feet beyond where the preceding train has stopped and the result is a collision.

An effort has been made to meet these new conditions by placing a signal back into the block (commonly called the overlap) to indicate the position of the home signal; this is also operated by a lever, interlocked and included in the combination governing the system. This will lessen the danger, but with this mechanical arrangement the signal cannot be placed back far enough to entirely eliminate the danger. Another point of danger is that an operator can unlock the signal in the rear, if his own lever has been unlocked, and thus permit a second train to come into the block. The Hall Signal Company now have an improvement on the Sykes system which covers this point, and is arranged so that a train in passing out of the block depresses a track instrument, this is connected electrically with the unlocking device, so that it is necessary for at least a part of the train to pass out before the lever can be unlocked.

There is still another and greater chance for an error in this system as well as in all other non-automatic systems. We must depend upon the operator to see that *all* of the train passes out of the block. As you know well all trains carry "markers" to denote the last car. The operator is expected to see the markers and not to report the train clear until he does see them. If the train has broken in two parts and the first part goes by the office and the operator fails to notice the absence of markers it is quite probable he will report "train clear" and the following train will be admitted to the block under a clear signal to find the detached portion of the preceding train unprotected by a flag, as the trainmen depend upon the block signal and do not get very far from their caboose. It is claimed for the Sykes system that two persons must make a mistake before a wrong signal can be given. This is true in so far as the unlocking part is concerned; but as I have shown in the case of a train stopping soon after the passing of the block, an accident is possible even with all regulations obeyed, but in the last case *one* man makes the error by failing to see the markers.

The arrangement of the pneumatic system seems to cover these points, but I believe the same protection is afforded by any other system that is operated by a track circuit and with very much less machinery to get out of order.

If we then conclude that the present systems must be improved to insure absolute safety, what will be the system of the future?

Will it be entirely automatic by means of the rail circuits?

Will it be electro-pneumatic with an attachment to the last car, or will it be, as a writer in the *Railway Equipment Guide* for April suggests: "A system that will display signals continuously throughout each block, so that the signal to proceed or stop will always be in view of the engineer." This idea strikes me very favorably. With such a system the operator controls the line of signals for a certain distance in the blocks each side of his station. In any event, it is my opinion that electricity will play an important part in the block signal of the future, and as the superintendent of telegraph, or division operator, is the man to whom electrical matters are intrusted, I venture to bring the matter before the members of this association that we may keep in advance of the movement, and in the hope that some one of you will be fortunate enough to devise the system that will meet all the conditions.

My own experience and observations have led me to believe that a combination of automatic and manual will meet the requirements, and I would suggest that the blocks be not less than three-quarters of a mile—the home signal operated by a lever, and signals operated by electricity and gravity or air pressure placed 1,000 or 1,500 feet apart throughout the block, the circuit connecting these signals to be also connected with the lever at the home station, so that in moving the lever to place the home signal at danger the circuit will be opened and the signals go to danger by gravity or weight. These signals will give ample notice of the position of the home signal and protect a train stopping just beyond a block station; it also admits of giving notice to the train should the block ahead clear after the train passes the distant signal, and schedule speed may be resumed before the train reaches the home station.

To eliminate the chance of an operator unlocking the lever while any part of the train is in the block I would suggest, in addition to the above, electrically connecting and insulating one line of rails throughout each block; this rail would have to be free from contact with cinder ballast; stone ballast gives best results. Then run taps from this rail circuit to one side of the metallic line circuit which is used to unlock the lever at the office in the rear. A train passing over the block will ground the side of the circuit connected by taps to the rail, close the relay and the local circuit of this relay will then lock the lever which operates the home signal, open the circuit of the block in rear and will remain so until the last pair of wheels connected by a metal axle passes out of the block. With this arrangement it will not be essential that the operator sees the "markers."

There will, of course, be objections raised by railroad officers to depending upon electricity, and their past experience may justify them in doing so, but I believe that it *can* be depended upon and, in my opinion, the day is not far distant when it will be.

All failures can, undoubtedly, be traced to defective designs or instruments, failure through inattention to the batteries or perhaps all together. We have track circuits, both open and closed, also electric signal circuits, normally closed, and I require that a closed circuit battery be renewed every fourteenth day, no matter what its conditions may be, new zincs placed in the track battery and using the cleaned zincs in the local circuit.

With this systematic way of handling the batteries, and having reliable men to do the work, and to watch the circuits, there will be no failures of the electrical parts. We have been experimenting with the Beatty zinc on our track circuits with very good results. The zinc is self-cleaning, and always presents a clean surface; and if the solution is kept at a proper strength, a uniform current is given out, so that changing the adjustment of relays is unnecessary. We are also trying them on normally open circuits, and expect to use them to replace Leclanché cells with gravity, as they do not run out if short-circuited. The first cost of the Beatty zinc is a little more, but a less number of cells are required, and the zinc does its work until nothing is left but the stem.

Since we arrived here our attention has been called to a new battery, in which, if further tests prove as satisfactory as those already made, the zinc will no longer be needed, which is a long step toward the ideal gravity battery.

With a good and reliable battery, I believe that electric signals and highway crossing bells will come more generally into use, and, by requiring strict attention from men in charge, our officers will soon lose their distrust in electrical appliances, and recognize in them very useful and economical adjuncts to the service.

The Government Time System in Its Relations, Practically, to Railroad Matters.*

BY W. A. GARDNER.

I shall not trespass on time or patience with description of systems and devices experimented with in the attempt to accurately transmit electric impulses for marking time. I shall restrict myself to the United States government system, adopted after many years' experiment with other plans and mechanisms, and which since its adoption has given satisfaction to all parties receiving and depending on its signals.

Passing to that part of the Observatory's equipment devoted to the work of establishing a standard time service, I find that there is much confusion of idea, even lack of information. Such inquiries are common, as: Where do the government time signals come from? and, How are they sent?

There are two officers to keep the clocks correct. Observations of the stars are taken by them every night, weather permitting. As you know, all of the "time" stars have been observed so many hundreds of times that one can now know beforehand exactly the instant when any one of them should pass the line of his transit telescope to the hundredth part of a second. The accuracy of your standard time, after all, depends upon the movements of these heavenly bodies, and upon the accuracy of the observations made upon them. They are the ultimate and the most nearly absolutely accurate standard. All human contrivances are merely compromises, subject every instant to variations from the fixed standard of the stars.

These two observers make special observations, each upon, we will say, a single star, and with these before them they derive the exact instant of the transit relative to a sidereal clock. Next they compare the reading of this clock with that of a mean time clock, and by the comparison ascertain exactly the error of the latter, that is, ascertain its variation from the star standard which has occurred since the last comparison. This variation they are able to measure by the chronograph and other instruments (which we cannot now discuss) to hundredths of a second.

The time signals are sent out from the Government Observatory at noon, the observations having been made the night before, and the comparisons having been made in the morning as late as is practicable in order to eliminate the chance of variation between the time of closing the comparison and the time of transmitting the signals.

At a few moments of 12 o'clock everything is ready for the transmission over the telegraph wires of the signals, first those signals of a preliminary or attention calling nature, and, finally, that one which is to indicate the predetermined instant, as, for example, the instant of noon.

Now, how shall these preliminary and the final signals be transmitted?

In order to eliminate the error arising from transmitting the signals by hand, the writer many years ago set about devising and perfecting some plan for obviating the intervention of the human hand at any point. These efforts culminated finally in the automatic system of transmission which is now, and has been for a long time, continuously employed with entire satisfaction. This automatic plan depends upon the introduction of a third clock in the series, namely, the transmitting clock.

At about 11:30 A. M.; the difference between the time of the mean time clock and the true sidereal time having been exactly found, the latter is by addition or substraction applied to the third or transmitting clock. Assume that the mean time clock is fifteen-hundredths of a second slow, and the transmitting clock fifteen-hundredths of a second slower than the mean time clock, then the transmitting clock is for a moment or two accelerated until it indicates a time thirty-hundredths of a second fast of the mean time clock, or in other words indicates the correct time. In this way the transmitting clock is caused for a few minutes in the day to indicate correct time as absolutely accurately as is possible with human instruments. And during these few moments it is utilized to open and close the electrical circuits which transmit, first, the preliminary, and, ultimately, the final time signal.

The simple instrumentality which finally accomplishes the signal transmitting is a toothed wheel secured to the seconds arbor of this transmitting clock. Teeth are removed so as to cause those characteristic gaps or intervals now recognized by telegraphers universally over the United States. For three minutes prior to exact noon the impulses are transmitted at each second, with the exception of the well known gaps or interims.

From the Naval Observatory telegraph loops extend to the main Washington office of the Western Union Telegraph Company. At the latter the signals are transferred by numerous multiple repeaters to a large number of main lines which distribute them over 300,000 miles of main and local wires throughout the United States.

So extended has the system become that it is safe to say that at noon to-day that small wheel automatically affected the armatures of twenty thousand receiving instruments.

It is not our purpose to discuss at any length the various receiving instruments which have been experimented with, and of which two or three sorts have been largely introduced. The two that are possibly the most widely used are known as the "Gardner" clock and the "self-winding clock." So far as concerns the reception of the synchronizing or controlling

*A paper read at the eleventh annual meeting of the Railway Telegraph Superintendents, Denver, Colo.

*Abstract of a paper read at the eleventh annual meeting of the Railway Telegraph Superintendents at Denver.

impulses, these are, or may be, essentially similar. The difference lies in the motive power for the clock trains, that in the Gardner system being the one which the experience of horologists has maintained for hundreds of years, to wit: gravity, acting entirely independently of the electric current, and in the other, being a battery and a motor. Each of these also has its numerous advocates.

Probably marked improvements will yet be made, but the principal thing of interest here is that they provide a means for avoiding the intervention of the human hand in the transmission and repetition of a signal.

As stated at the outset, I do not profess to have a knowledge of all the details involved in railway time service, and will not presume to instruct or advise in respect to its management. Yet, I take the liberty of offering two or three suggestions which may provoke attention even if erroneous.

First. So far as possible all hand work should be avoided, and automatic receiving and distributing should be employed even at the most distant points. Careful tests over comparatively long periods of time have shown it practicable to transmit the signals over thousands of miles with a variation never exceeding a few tenths of a second.

Second. I suggest that after selecting the observatory which is to be your authority, you receive its signals direct throughout your whole system at least once daily; instead of receiving the Observatory signals only at some central station, and at another hour retransmitting them from there. It may be that for special reasons a road will advantageously transmit its time signals at some special hour. But I am strongly of the opinion that (supposing proper instruments are introduced at all intermediate points) the best results are attained when the observatory time is directly and universally distributed. After its reception each system may for one reason or another utilize some other hour for its special time work.

Third. I suggest that, so far as possible, use be made of automatic recorders, specially adjusted and exclusively used for recording the signals. If it be only a Morse register it is advisable to use it. With a recorder at every important point (such as a branching, distributing or repeating point) responsibility for error or failure can be located quickly and satisfactorily.

Fourth. I submit for consideration in the light of your experience as telegraphers, this: that, wherever possible, the use of duplex and quadruplex instruments should be avoided, and that for the receiving, repeating and distributing of the signals; instruments should be temporarily substituted which are simple in construction, sure in operation and easily kept in adjustment.

A New Fan Motor.

The Interior Conduit and Insulation Company of New York is bringing out an entirely new form of fan motor, the invention of Mr. Robert Lundell, who is connected with the company.

Many attempts have been made to design dynamos and motors in which there should be practically no magnetic leakage, but these attempts have not met with any marked degree of success. In an ordinary motor the leakage often amounts to from 40 to 50 per cent., thus requiring an extra heavy magnetic circuit and producing a field magnet of low efficiency. The practical elimination of all magnetic leakage constitutes the chief factor of superiority in this motor. The armature and pole pieces are surrounded by a single magnetizing coil, which in turn is itself totally surrounded by the keeper or yoke, as is shown in the sectional view, Fig. 3. thus leaving no chance for stray magnetism. It is a true iron-clad field magnet, having at the same time the shortest possible magnetic circuit. The keeper would form a perfect sphere were it not for the slight projections constituting the bearings.

FIG. 1.—SUSPENDED MOTOR.

The motor assumes remarkably small dimensions for any given capacity, due to the fact that every cubic inch of space inside the spherical keeper is effectively utilized. It is also very light on account of a short magnetic circuit, having small cross section, with comparatively few turns of wire in the magnetizing coil. The type of armature adopted is a modern Pacinotti drum, proportioned with a view of maximum efficiency. Particular attention has been paid to the shape of pole pieces in relation to the reaction between armature and field magnet, and thus the motor has been rendered sparkless, and the point of commutation remains fixed between the limits of load and at reversal of rotation. The need for a special rocker arm for supporting and adjusting the brushes is consequently obviated. The brushes themselves are small carbon pencils fitted in bayonet jointed holders, and held upon the commutators by a small spiral spring. The new motors are furnished in five different styles, and are richly finished in black japanning with red and gold striping. The 1-12 h. p. motors are all fitted with ball bearings which require no oil, a most valuable consideration. This size runs at a maximum speed of 1,800 revolutions per minute, a minimum speed of 900 and a mean speed of 1,500 at 110 volts, while the 1-6 h. p. motors have a maximum speed of 1,800 revolutions, a minimum speed of 900 and a mean speed of 1,000 revolutions per minute.

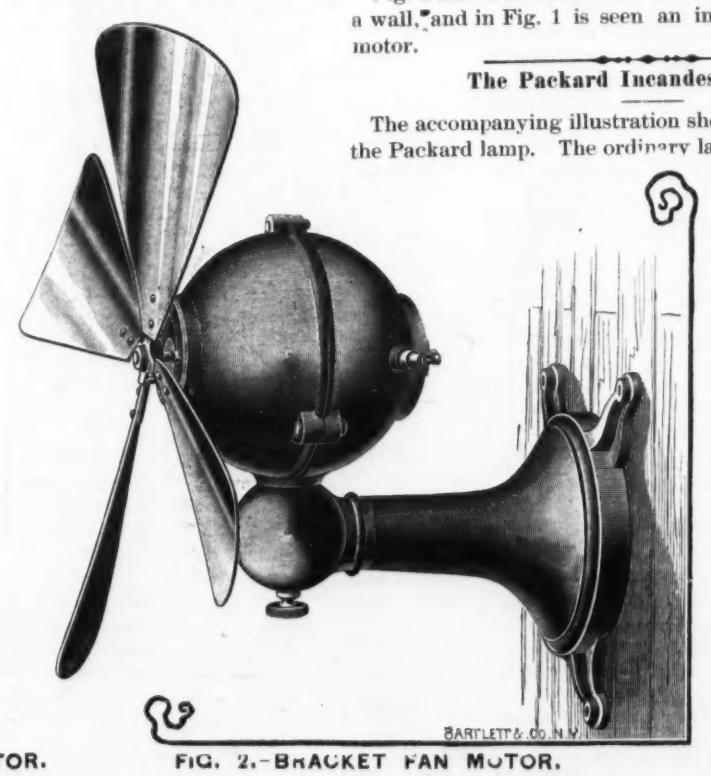
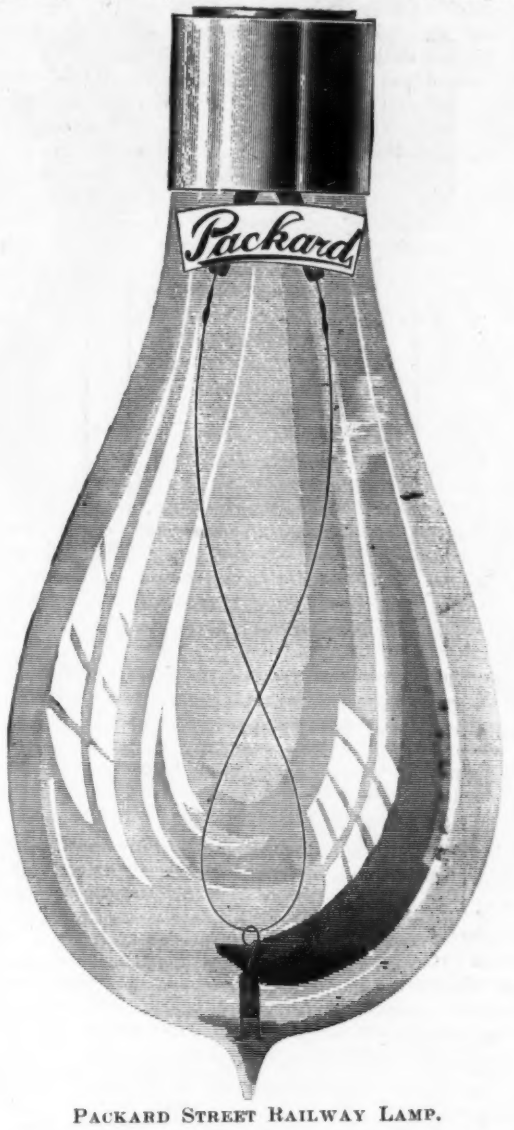


FIG. 2.—BRACKET FAN MOTOR.

Fig. 2 shows a bracket fan which is very easily affixed to a wall, and in Fig. 1 is seen an ingenious suspended fan motor.



PACKARD STREET RAILWAY LAMP.

The Packard Incandescent Lamp.

The accompanying illustration shows the latest type of the Packard lamp. The ordinary lamps are made in sizes of 8, 10, 16, 25, 32 and 50 c. p. This cut represents the tied filament or railroad lamp. The filament is supported by a platinum hook. Sufficient space is given so that the carbon does not rest on the platinum except in case of violent vibration, when such support is necessary. Great care is taken in the manufacture of this lamp, and the reports of practical tests are very favorable. It is claimed that at a test in one of the largest central stations in the country out of a dozen different makes of lamps the Packard was one of the three that survived to the end and kept up its candle power to a remarkable degree. The lamp is manufactured by the New York & Ohio Company, Warren, O., with Mr. Chas. E. Chapin, 136 Liberty street, New York, as Eastern agent.

C. & C. Switches.

The accompanying cuts represent the single and double pole switches recently placed upon the market by the C. & C. Electric Motor Company. The plain switches designed

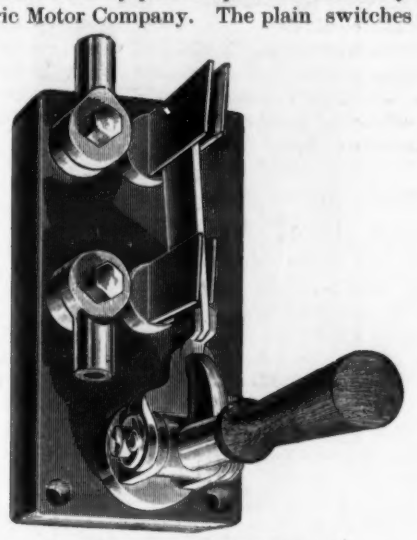


FIG. 1.—C. & C. SWITCH.

by this company have the same general appearance, the only important difference being the omission of the snap spring in the plain switch, while the handle lever and knife lever are replaced by a single casting.

Almost all specifications for electric lighting plants now call for marble or slate switchboards instead of the wood board, which was formerly considered satisfactory. The switches that were designed for the wood boards have been made to do service on the marble, but owing to their construction they do not always make a handsome appearance. The switches here illustrated were designed specially for this class of work and have been provided with ample contact surface and quick break, and the metal parts are so solidly constructed as to obviate any possible danger of breaking.

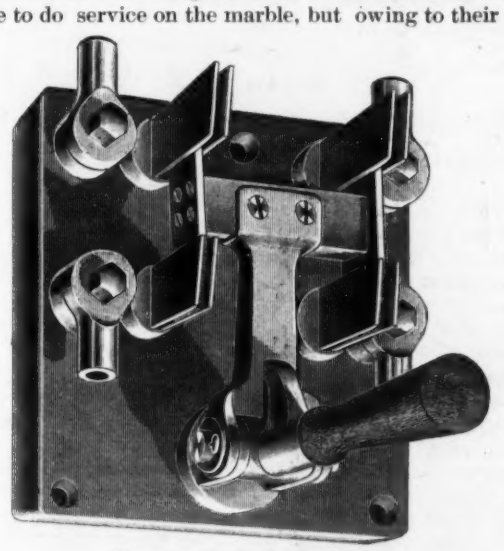


FIG. 2.—C. & C. SWITCH.

The connections are made from the back of the switchboard to these switches, but the contact binding posts are made extra long so that when wanted the switches may be supplied to be fitted to a switchboard of any thickness. On switches provided with the fuse blocks and mounted on slate bases, the distance between the fuse terminals is made ample enough to render the fuses perfectly reliable and to prevent any danger of arcing across. This feature is specially desirable when the switches are used on 500 volt circuits.

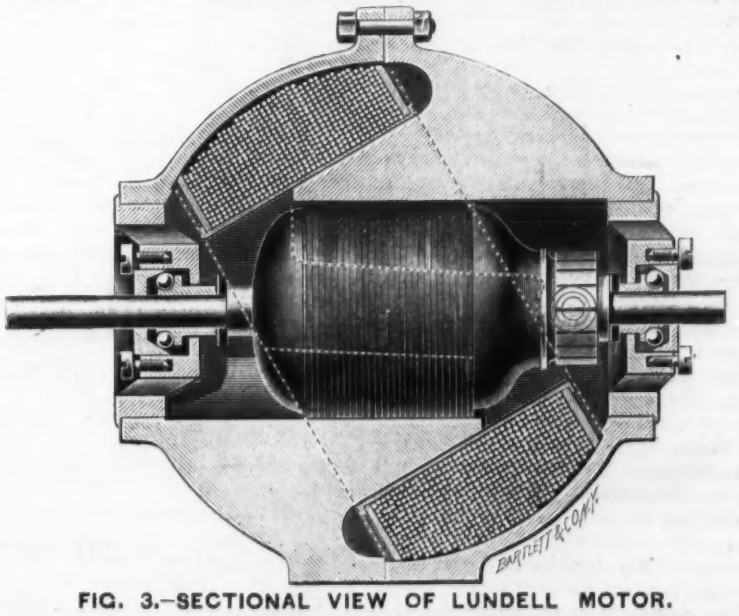
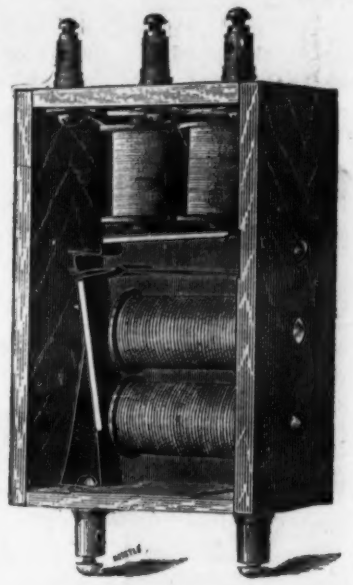


FIG. 3.—SECTIONAL VIEW OF LUNDELL MOTOR.

The Sechrist Automatic Switch.

The accompanying cut illustrates a new automatic switch invented and controlled by Mr. Albert Sechrist, of Denver, Colo. Its method of working is apparent. The two electromagnets are controlled by two battery circuits which contain push buttons, one for lighting and one for extinguishing the lamps. According as one or the other of the magnets is excited one of the armatures is attracted and

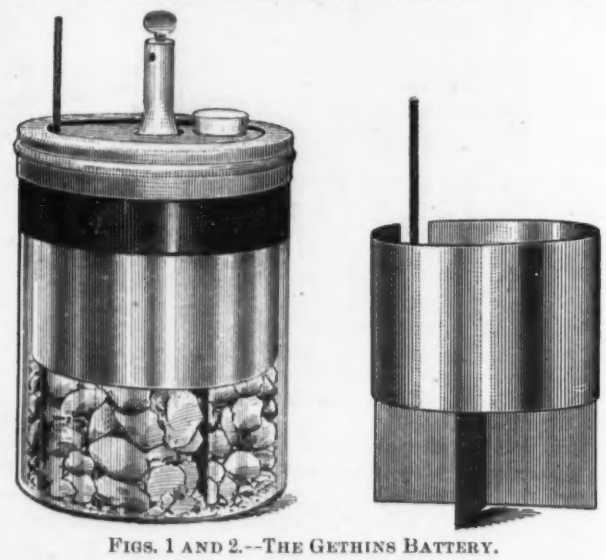


THE SECHRIST SWITCH.

the circuit opened or closed. This makes it possible by having banks of buttons placed at different points to control any light in a house. For instance, a person can go through the house lighting the lamps before him and extinguishing those behind. The simple push button is not only much more ornamental and less conspicuous than the ordinary switch but requires only small battery circuits to be led over the house instead of the lighting circuit, thus avoiding both expense and danger. This switch is also usefully applied to burglar alarms.

The Gethins Gravity Cell.

An improved form of gravity cell manufactured by the Gethins Electrical Manufacturing Company, of Boston,



FIGS. 1 AND 2.--THE GETHINS BATTERY.

Mass., is shown in the accompanying illustrations. In this battery it has been sought to reduce the internal resistance of the original cell, and to do away as far as practicable with all the unnecessary labor attached to gravity batteries.

It will be noticed that the copper plate supported

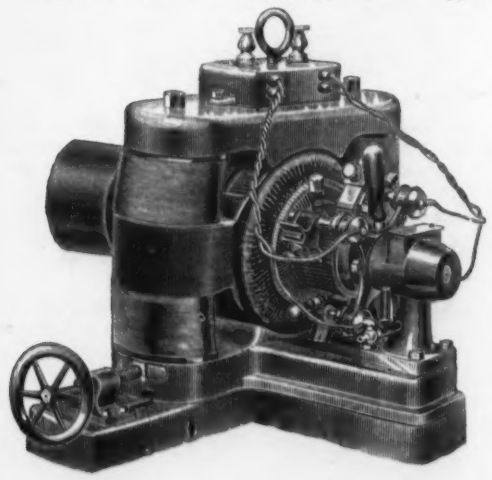
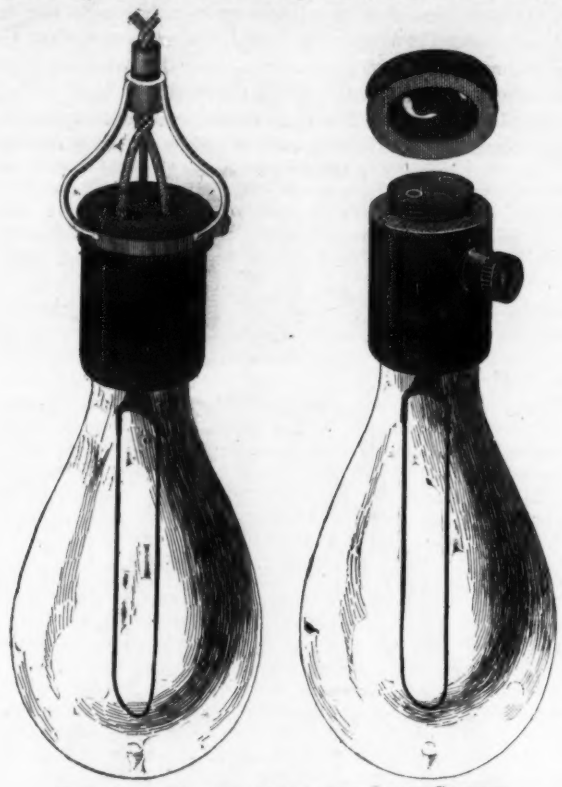


FIG. 1.—DUPLEX DYNAMO.

by the lower cross pieces surrounds the porous cup in the upper part of the jar, and is thus brought in close proximity to the zinc. This construction reduces the internal resistance of the cell to about 1.5 ohms with ordinary zinc sulphate solution in the porous cup, while with a solution of sulphuric acid the internal resistance is but .5 of an ohm. It has been found that the addition of a sealed cover not only entirely prevents climbing salts, but also prevents the condensation of the zinc solution, and the consequent sudden increase of resistance in the battery, and in fact does away with all attention. This has been demonstrated by a number of tests extending over the past year. Four cells of this battery containing four pounds of sulphate of copper and two pounds of zinc were given a careful test extending over eight months, and with quite remarkable results, it is claimed, and the cells which have received no attention whatever are still in good condition.



FIGS. 1 AND 2.--THE BAILLARD LAMP SOCKET.

A New Lamp Socket.

A novel form of lamp socket is shown in the accompanying illustration. It is the invention of Mr. Geo. C. Baillard and has just been put on the market by Doubleday, Mitchell & Co., 136 Liberty street, New York. The method of construction is very simple, and it is an easy matter to connect the socket to a circuit. All that it is necessary to do is to bare the ends of the wires, insert them in the openings seen in the top of socket, and give the cap a twist to the right. This hold the wires firmly, and insures good contact. The lamp and socket are made together as one, and the lamp is not removable, as in the common form. When the lamp burns out the whole is easily disconnected from the circuit and returned to the manufacturer, an allowance being made for the socket, and a new one is put on. In this way the consumer always has a new, clean socket, if it may be called a socket. The socket is water and weather proof, and so can be made of any non-conducting material such a hard rubber, fibre, glass or porcelain. Fig. 2 shows a keyed socket, which is slightly more expensive than the keyless form, which is seen in Fig. 1. For connecting to a fixture a brass collar goes around the cap, with three small arms going up and fastening to a bushing, which can be screwed to the fixture if necessary. Three arms may also be brought down from this collar to serve as a shade holder. Great rapidity of connection is claimed for this socket. With the ordinary form, where the workman has to take off the cap, jacket, and sometimes a rubber ring to connect the wires, and then to replace them, it is said that 45 sockets in a day is about the limit, while with this improved form it is claimed that at least 200 sockets and lamps can be connected in a day.

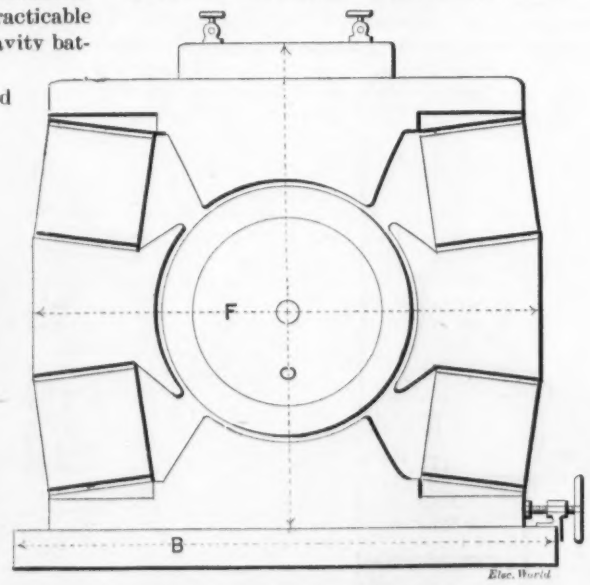


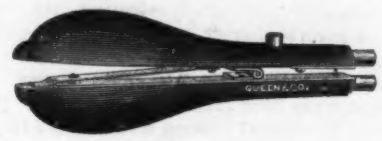
FIG. 2.—THE DUPLEX DYNAMO.

Duplex Dynamo and Motor.

The new, slow speed, multipolar incandescent dynamo and motor manufactured by the Duplex Electric Company, of Corry, Pa., is shown in the accompanying cuts. This machine is small for its capacity, and on account of its compactness takes up little floor space. Fig. 1 is a general view, while the outline cut Fig. 2 gives a better idea of the disposition of the poles and fields. Like the bipolar generator that this company makes, this machine is thoroughly automatic, requiring no resistance coils or rheostats.

Portable Testing Keys.

While practically all galvanometer and other electrical keys are portable in that they can be carried about, yet the type illustrated herewith is decidedly unique and is likely to be very useful. Every one who has occasion to make insulation tests away from a laboratory knows how essential it is to have apparatus that is reliable and at the same time



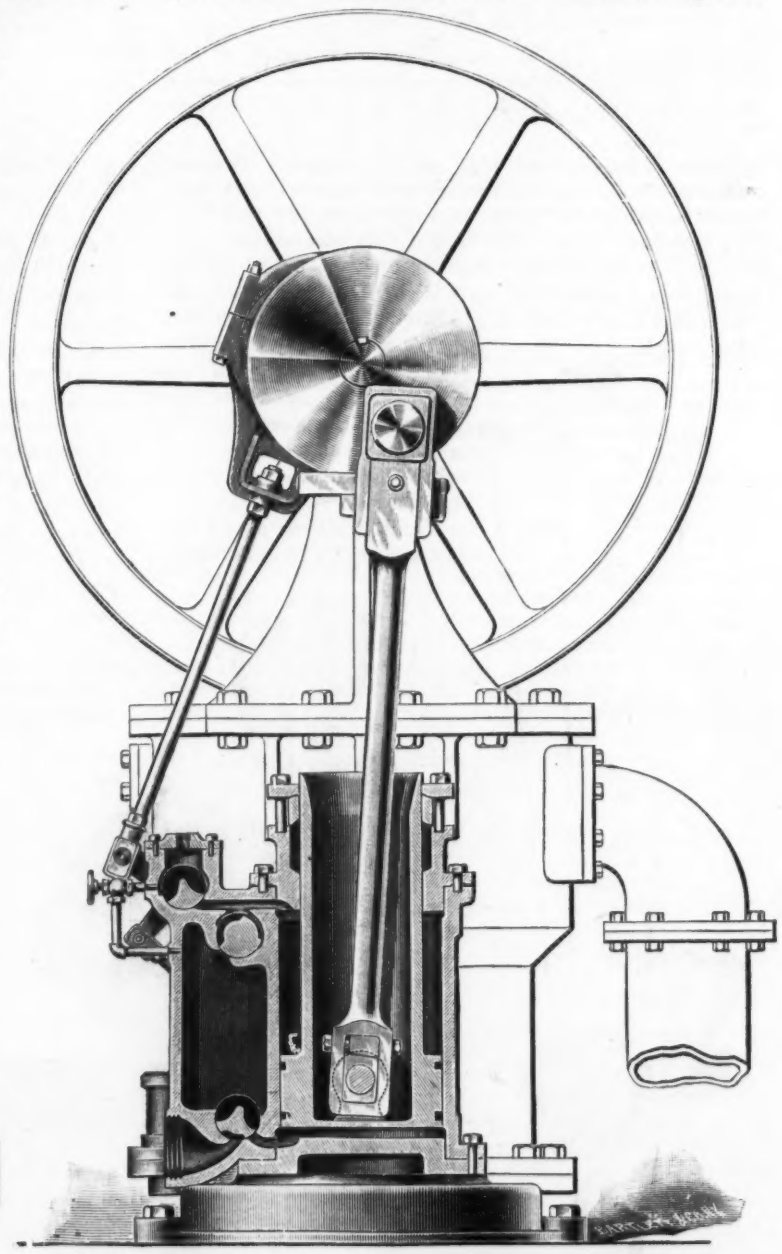
PORTABLE TESTING KEY.

adapted to surrounding circumstances; that is, accuracy must be combined with portability.

A short circuit key or a contact key that can be thrust into one's pocket will commend itself for convenience to those engaged in outside work. Queen & Co., of Philadelphia, claim that they can fill the bill with their new products. The keys are make of hard rubber, polished, with brass connections and platinum contacts, and the desired effect is produced by simple pressure of the hand. None are longer than five and one-half inches, and they weigh not over five ounces each. Three forms are now made, viz., single contact, double contact and short circuit.

The Conover Independent Condenser.

In the description of the Conover independent steam engine condenser made by the Conover Manufacturing Company, 95 Liberty street, New York, which was published last week, the perspective views, while giving an excellent idea of the general arrangement of the condenser, did not show the details of the interior construction, which seems quite essential to a proper understanding of it. The accompanying illustration shows a sectional view, and in connection with the description already published will give a clear understanding of the construction and operation of this machine.



INTERIOR CONSTRUCTION OF CONOVER CONDENSER.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK AND BOSTON, June 25, 1892.

Financial Matters in New York.—The Wall Street market during the week has been to a marked degree a professional market. The bulls and bears have approached nearer the same plane of values under a general adjustment of conditions than they have for some time. Trading was based largely upon reports of crops, more or less conflicting. After the middle of the week the street, if developments are indicative, devoted most of its time to inventing rumors. These were both of a bear and bull order, and in many cases were productive of dire results. Gold exports, as was predicted in our last report, were very heavy, amounting to $5,100,000, against $7,100,000 last week. Eminent authorities are quite unanimous in declaring that there will be a marked cessation in the gold movement during the month of July. The money market is a shade firmer on these excessive exports and reports of July disbursement. The supply continues very ample, and will probably be more so after the Fourth. New York exchange is at a discount at Boston, par at most Eastern cities, and at a premium generally West and South, Minneapolis being the exception, it selling there at a discount. Time loans in the West range from 3 to 8 per cent.

The General Market in Boston.—The week has been a good one on general principles, and the conditions evidently are founded upon legitimate reports of true values behind the prices. Quotations show something of an advance over last week. The bulls have met with moderate success in strengthening prices, as collateral reports and influences have tended to incline in their favor. The gold exports have been moderate, and only about one-half what they were last week. The gold movement for May was satisfactory in being rather below the average. Though the shipments in June exceeded the usual average for this month, still the aggregate for the year will be far less than a year ago. The import statements will likewise make a better showing than they did then. Gold movements, crop reports and the Chicago Convention have been the three most important factors that could in any marked degree affect the market, and all of them this week have been most favorable. Experienced bankers say that this week's shipments will practically end the gold exportation for the year. Some change may result in money rates from the large disbursements which will come out July 1. Millions of dollars will be paid in interest and dividends, which will be very widely disseminated, a condition which is always favorable.

New York Electric Stock Review.—There seemed to be a slight revival in trading in the best electrical securities this week. Western Union was quite active through the week, selling at 94¾ on Monday flat, and 93½ ex-dividend. It gained slightly during the week, reaching 94 on Thursday and ranging around 93¾ on Saturday. A rumor was circulated to the effect that foreign capitalists were negotiating with Jay Gould for a control of this property. However, this is probably as empty as Wall street rumors usually are. Commercial Cable surprised the street by selling 100 shares; the figure was 155. For over a month it has been steadily bid at 155 and held at 158. The sale at the price stated weakened holdings to 155½ asked and 154½ bid. American District Telegraph received a fair request, which eventuated in sales on Tuesday at 61½ and 6'. The American Telegraph and Cable sold in a limited way in the middle of the week from 85¾ to 86; on subsequent sales it lost ground to 85. North American, which was fully treated in our last report when it was selling around 14½, has led the career we predicted it would. It will be remembered we stated that its book value was between 13 and 14; this has been substantiated by quite numerous sales, and between 13¼ and 13½. We do not look for any advance in the value of the stock for some little time. There is a great field for the North American company and should it bring to a successful termination the many enterprises which it has under way the stock should sell for double what it now brings. If reports are to be credited Mr. Villard is working along these lines with much success.

Electric Stocks in Boston.—The electrics have had a quiet and strong week, with few sales and very little fluctuation of prices. The most important item in connection with the companies was the decision on the incandescent lamp filament. Patent decisions no longer play the important part in making prices that they once did, and the market shows no reflection whatever of this action, which is naturally of considerable importance to the companies at interest. There has been very little inquiry for Westinghouse common and preferred, and the price has changed only fractionally from last week. Thomson-Houston and Edison General have receded a point or two for lack of any interest to stimulate purchases. Bell Telephone and Western Union have entirely held their own, though the latter is a little lower than maximum figures. It takes more than an ordinarily dull market to disturb the equilibrium of these strong stocks.

The General Electric Company's stock is finally ready for delivery and the announcement has been made by the Old Colony Trust Company, of Boston, and the New York Guaranty and Indemnity Company that on and after July 1 the receipts for the Edison and Thomson-Houston stocks will be transferred for general stock, according to the terms of recent circulars, *i. e.*, share for share of Edison stock and three shares for five shares of Thomson-Houston common stock. For fractional parts of shares of the common stock of the General company new fractional trust receipts will be given to enable the holder to arrange by sale or purchase of more stock to gain a sufficient amount to secure an integral number of General Electric shares. The books of transfer of these receipts will be permanently closed Aug. 1, 1892. After that date we will hear no more of Edison General stock and Thomson-Houston stock, as each will have entirely lost its identity. The Massachusetts Loan and Trust Company, of Boston, also gives notice that on and after July 1 it will transfer trust receipts for Thomson-Houston International Electric Company's stock to General Electric Company's stock, It will also pay a dividend on the International preferred stock trust receipts of record June 28, of $1.75 per share. The balance sheet of the General Electric Company as of May 31, 1892, shows assets of $33,871,500. Of this amount the Edison General stock represents $14,644,200; the Thomson-Houston, 237,235 shares, $14,234,100; the T.-H. International, common, $868,800; T.-H., preferred, $3,836,700, and T.-H. International, preferred, $187,700. There is $74,785 in cash. Securities of this company have been listed on the New York Stock Exchange as follows: Common stock, $20,847,100; preferred, $4,024,400. From time to time the committee may list $612,900 common and $2 7,600 preferred. Of the $50,000,000 capital stock authorized, $15,288,000 remains in the company's treasury. The assets of the Thomson-Houston company Jan. 8, 1892, were figured at $20,263,447, and the surplus $7,546,947. The Edison General Electric Company had assets of $24,189,967. The stock sold in New York to the extent of 160 shares during the middle of the week at figures ranging from 107⅝ to 108. It did not become active, however, owing to the fact that it is considered worth more, as it exchanged share for share with Edison General Electric, which a couple of weeks ago had a market value of 111. It is all in strong hands.

Westinghouse Company.—The different electrical securities of the Westinghouse Company, which includes the Philadelphia Company, the Electric Common, the Air Brake, the Switch and Signal, the Underground Cable, have appreciated in value during the past year $6,527,000. There were no transactions in the stocks of this company on the New York Stock Exchange this week.

The Edison Electric Illuminating Company has listed on the New York Stock Exchange $900,000 additional capital stock, making listed $5,400,000, and $400,000 five per cent bonds, making the total listed $2,650,000. The new stock is used partly to retire convertible scrip, $300,000 remaining in the treasury; $200,000 of the bonds will be similarly disposed of. The balance of both the bond and stock issue is to be used for additions and betterments. The net earnings of the company for four months of 1892 were $161,894, against $347,228 in the entire year of 1891. Subscriptions for these new stocks and bonds were all taken before June 21, not a share or bond being left for the underwriting syndicate. This is indicative of the faith of shareholders in the value of their investment. The rights to subscribe to this stock on Monday sold at 1⅞ per cent. to 1¾ per cent., and were in good demand. Sales of the stock took place at 84

Electric Street Car Bonds.—It is reported upon good authority that Mr. Henry Villard during the month of June has sold upward of $1,500,000 of bonds issued on the electric street car system of Tacoma. They are said to be no part of the assets of the North American Company, and that the company had nothing to do with the sale of them. In this connection we hear the report that Mr. Villard's northwestern interests will receive adequate financial assistance that has been needed for two years.

Postal Telegraph Company.—A rumor gained considerable currency in Wall street last week to the effect that negotiations were in progress for some sort of a reciprocal arrangement between this company and the Western Union. A representative of THE ELECTRICAL WORLD obtained from Mr. Theodore L. Cuyler, Jr., assistant treasurer, a statement to the effect that it contained no truth whatever; that the Postal Company had been developed in direct opposition to the Western Union; that it was in excellent financial condition; that it reached every section of territory covered by the Western Union in which it cared to do business, and that any reciprocal arrangement would be of no possible benefit, but a positive injury. He also said there had been no recent sales of stock, as shown by the books of the company, and was certain that there are no attempts being made to buy control.

Central & South American Telegraph Company.—About two weeks ago THE ELECTRICAL WORLD stated that it had the best of authority that this company would issue bonds for the duplication of its line from Santa Cruz, Mexico, to Chorillos, Peru. This has been verified by the official circular just issued, offering to shareholders until July 15 the right to subscribe at par for $1,500,000 construction certificates convertible into stock. The holders of 100 shares to have the right to take 23 per cent. of the new issue. The terms are 10 per cent. payable in cash; 20 per cent. Aug. 1; 15 per cent. each Sept. 1, Oct. 1 and Nov. 1, and 25 per cent. on Jan. 15, 1893. Certificates are exchangeable into stock within three years after completion of the work. In connection with the Mexican Telegraph Company this company is operating 7,100 miles of line from Galveston, Texas, to Buenos Ayres. The Mexican Telegraph Company contracts to pay the company $20,000 per year for three years from completion of the duplicate cable. English contractors, it is stated, will perform the work. The Central & South American Company has declared a dividend noted elsewhere in this issue of THE ELECTRICAL WORLD. The following statement accompanies the dividend announcement:

Surplus March 31, 1892		$292,316
June 30, 1892, three months' receipts, partly estimated	$183,591	
Operating expenses	68,000	
Net	$115,591	
Dividend	110,390	
Increase of surplus	$5,201	5,201
Estimated surplus		$297,517

Bell Telephone.—The instrument output of the Bell Telephone Company for the month ended June 20, and for the fiscal year to date, is reported comparatively as follows:

Month ended June 20:	1891.	1892.	Inc.
Gross	8,912	8,211	701
Returned	4,414	2,667	1,747
Net	4,498	5,554	*1,046
Since Dec. 20:			
Gross	50,124	37,924	15,200
Returned	26,610	18,761	7,849
Net	23,514	19,163	4,351

*Decrease.

Offering of Bonds.—Jones, French & Maury, of New York, offer for sale 40 year five per cent. gold bonds of the Buffalo Street Railway Company. They offer $40,000 for sale, which are the remainder of a larger issue. The bonds are secured by a first mortgage of $5,000,000 on the entire system of street railways in Buffalo, N. Y., owned and operated by the Buffalo Railway Company. The bonds have 38⅓ years to run after Aug. 1, 1892. The motive power has recently been changed from horse power to electricity. The net earnings of the company for six months ending Dec. 31, 1891, were $184,463.15. The gross earnings from July 1, 1891, to June 1, 1892, were $912,721.61, a gain over the corresponding period of the previous year of $177,719.72. The net earnings for the month of May, 1892, were $36,193.72, an increase of $19,681.38. The capital stock of the company is $6,000,000, and at present the market price is 39. A large portion of the stock and bonds of the company are held in New York, Philadelphia and Boston. The bonds are offered at 95½ and interest and are highly recommended as secure and profitable.

Dividends.—The United Electric Securities Company has declared a dividend of $1.50 per share, payable Aug. 1, to stockholders of record on July 20. The International Bell Telephone Company has declared a dividend of five per cent. payable July 1. The Cincinnati Electric Light Company, three per cent., payable July 1. The Central and South American Telegraph Company has declared a quarterly dividend of 1¾ per cent., payable July 2.

Increase in Capital Stock.—The Hartford, Conn., Electric Light Company has voted to increase its capital stock from $200,000 to $250,000. Five hundred new shares of $100 each are to be issued, each stockholder being allowed to subscribe for one new share at par for every four shares now held. The new stock is to be paid for by July 15. It is proposed to increase the capital stock of the Southern Massachusetts Telephone Company $50,000; its present capital is $450,000. It has been voted to increase the capital stock of the Worcester, (Mass.), Leicester & Spencer Electric Railroad from $250,000 to $375,000. The Pittsburgh, (Pa.), and West End Railway Company has voted to increase the bonded indebtedness of the company from $75,000 to $500,000.

The Copper Market has been exceedingly dull this week. The little movement manifested has been confined almost entirely to the electrical demand. Small lots of lake sold at 11¾c. for ingots, 11⅞c. for bars. Should there be a general revival of trade this electrical demand will be felt in prices. The companies claim not to be selling for less than 12 cents and talk quite bullish on the situation. The falling off in the home consumption is manifest by the increase in the exports, as compared with the previous weeks of the market. There were sent out from the port of New York 296,403 lbs. of 55 per cent. matte and 592,693 lbs. of fine copper.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, June 25, 1892, in New York, Boston and Chicago.

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American Bell Tel	100	17,500,000	....	....	....	..
Debentures subject to call at 100	...	2,000,000	....	....	....	..
American District Tel	100	3,825,000	61	62	61	62
American Tel. & Cable	100	14,000,000	85	86	85	86¼
Central & So. Am. Tel	100	6,000,000	....	....	....	..
Commercial Cables	100	7,716,000	....	155	154½	155¼
Debentures	...	1,000,000	....	....	....	..
Erie Tel. & Telp	100	4,800,000	....	....	....	..
Gold Stock & Tel	100	5,000,000	..	....	100	103
Bonds	500	500,000	....	....	100	..
Mexican Tel	100	2,000,000	....	....	....	..
Northwestern Tel	50	2,500,000	....	....	....	..
First Mort. Sinking Fund	500	1,180,000	....	....	....	..
Postal Tel. & Cable	...	10,000,000	....	....	62	64
Southern & Atlantic Tel	25	948,775	....	....	78	84
Western Union Tel	100	15,000,000	93¾	93⅞	9.⅝	93⅞
Real estate bonds	1,000	1,219,000	....	....	....	.
Debenture bonds	1,000	4,920,000	....	....	....	..
" sinking fund bonds	500	841,266	....	....	....	..
Collateral Trust 5's	1,000	8,181,000	....	....	....	..
North American	100	39,767,200	13⅛	13⅛	13¼	13⅜
Brush Ill. Co. of N. Y	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y., exright	100	6,500,000	....	....	84	84½
Edison El. Il. of Brooklyn	100	750,000	...	....	85	90
" " " " Chicago	100	750,000	....	....	130	145
" " " " Boston	...	.....	....	....	115	126
Edison El. Lt. Europe	1,000	2,000,000	....	....	2	6
" Bonds	...	30,000	....	....	65	80
Edison Ore Milling Co	...	2,000,000	....	....	15	20
East River El Light	100	1,000,000	....	....	....	65
General Electric	1,000	50,000,000	107⅝	108	107¼	108¼
Automatic Exhibition Co.	...	2,500,000	..	....	3	5
Mt. Morris Electric	...	500,000	....	....	....	65
N. E. Phonograph	...	2,000,000	....	....	2	4
N. Y. Phonograph	...	2,000,000	....	....	2	5
North American Phonograph	...	2,000,000	....	....	4	6
Westinghouse Elec & Mfg. Co. 1st p. 7 per cent. Cum.	50	3,717,253	94	95	94¾	95
E. & M. Co. Assg	50	5,038,116	58¾	60	...	..

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	65¼	64½	64⅝	64⅞
Thomson Houston Elec. preferred	25	4,000,000	30½	....	30	30¼
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8½	9
Thomson-Houston Elec.—Series D	sh	120,000	7½	..	7¼	7⅜
Thomson-Houston Int'n'al Elec	100	600,000	....	....	250	260
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	106
Thomson Elec. Weld	100	1,000,000	....	....	55	60
Thomson European Elec. Weld	100	1,500,000	12	....	10	12
Westinghouse Elec.—New Com.	..	6,000,000	29¼	28¾	28¾	29⅛
Westinghouse Elec.—Pfd.	..	4,000,000	18	45¼	45	46
Fort Wayne Elec	25	4,000,000	12¾	....	12½	12¾
Fort Wayne Elec.—Ser. A.	sh	80,000	7½	....	7¼	7½
Detroit Elec	10	1,000,000	....	....	7	7⅛
West End St. Ry. Co.—Com	50	7,150,000	74⅜	73¾	73¾	74
West End St. Ry. Co.—Pfd	50	6,400,000	89¼	87⅞	88¾	89
American Bell Tel	100	15,000,000	207	206	205½	206
Erie Tel. & Tel. Co	..	4,800,000	44	43¾	44	45
Mexican Tel. Co	10	1,280,000	1.05	....	1.05	....
New Eng. Tel. & Tel. Co.	..	10,304,600	56	....	....	56
Tropical Tel. Co	10	400,000	....	....	20	30

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stock furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago	221	..	Iowa Union	20	25
Central Union	56	56½	Chicago Arc Light & Power Co	92¾	93½
Michigan	87	90	Chicago Edison Co.	160	..
Wisconsin	..	130			
Missouri & Kansas	..	56			

NEW INCORPORATIONS.

The Northern Electrical Supply Company, of Concord, N. H., has filed articles of incorporation. The capital is $5,000.

The Lemont Electric Light and Power Company, of Lemont, Ill., has been incorporated, with a capital stock of $1,000. The incorporators are J. G. Bodenchartz, T. J. Hutson and others.

The American Light and Heat Company, of Chicago, has been incorporated. The capital stock is $500,000. William J. Sanborn, Joseph H. Sanborn and Frank M. Blair are the incorporators.

The Neenah & Menasha Electric Railway Company, of Menasha, Wis., capital stock $150,000, has been formed to build and equip a street railroad. The promoters are Curtis Reed, W. R. Reed and S. Bullard.

The People's Light and Power Company, of Aspen, Colo. capital stock $200,000, has been formed to supply electric light and power to the citizens of Aspen. Geo. S. Newman, M. L. Stern and Chas. I. Thomson are the incorporators.

The Central Light and Power Company, of Peoria, Ill., capital stock $200,000, has been formed to furnish electric light, power, heat, steam power, etc. Walter Barker, J. Newell Ward and Walter S. Horton are the organizers.

The Normal Light and Power Company, of Normal, Ill., capital stock $25,000, has been formed to establish a water system and furnish electric light and power. John W. Cook, A. S. Hotfield and E. B. Hillman are the promoters.

The New England Electric Heating Company, capital stock $250,000, has been formed at Portland, to manufacture electrical heating apparatus. E. Jewell, Boston, Mass.; A. B. Smith, and L. L. Parsons, of Saugus, Mass., are the incorporators.

The Ashland Street Railway and Lighting Company, of Ashland, Wis., capital stock $75,000, has been formed. The incorporators are as follows: S. S. Fifield, George Hopper, J. H. Knight, Thomas Bardon and G. W. Harrison.

The Mountain Electrical Manufacturing and Construction Company, of Meyersville, Pa., has been organized with a capital of $20,000, for the manufacture of electrical supplies and appliances. George A. Smith is the manager.

The Passaic & Newark Electric Railway Company, of Passaic, N. J., capital stock $100,000, has been formed to operate a street railway. B. W. Spencer, B. Morrell, J. Kennell, W. R. Brown and F. M. Moore, of Passaic, N. J., are the incorporators.

The Bayard Building, Loan and Improvement Company, of Bayard, W. Va., capital stock $25,000, has been formed to

erect and operate hotels and electric light and water works. W. M. Brown, R. F. Whitmer and R. Workman, of Bayard, are the incorporators.

The Marietta Electric Light, Heat and Power Company, of Marietta, Pa., capital stock $1,000, has been formed to supply light, heat and power by means of electricity. Henry S. Rich, D. H. Case and Albert D. Wike, all of Marietta, are the incorporators.

Holland, Mich.—The Wolverine Electric Light Company claims that the recent election, by which it was decided to bond the city for an electric light plant, was not legal, and the concern has served an injunction on the City Council to prevent it from putting in the plant.

The Electric Railway and Power Company, of Tiffin, O., capital stock $50,000, has been formed to construct and operate electric street railways, and to furnish power, etc. J. M. Naylor, Geo. D. Loomis, B. W. Crobaugh, C. J. Yingling and Jos. P. Myers are the incorporators.

Pittsburgh, Pa.—At a meeting of the judges of the three Common Pleas Courts the action of the commissioners relative to the erection of a new building on the site of the old Criminal Court building for furnishing light and heat to the court house and jail was ratified. The plant is to cost from $150,000 to $175,000.

AFFAIRS OF THE COMPANIES.

The Gaynor Electric Company, of Louisville, Ky., has sold out to its rival, the Louisville Electric Company, for $25,000.

The Ypsilanti Electric Light Company, of Ypsilanti, Mich., is in process of reorganization with increase of capital stock and enlargement of its service.

Elgin, Ill.—The Elgin Electric Light Company has elected the following officers: President, E. C. Hawley; treasurer, H. W. Hoxie; directors, E. C. Hawley, G. F. Oatman and H. W. Hoxie.

The Rapid City Electric Light Company, of Rapid City, So. Dak., has re-elected its old officers, as follows: V. T. McGillycuddy, president and manager; James Halley, vice-president; H. W. W. Somers, secretary and treasurer.

Panora, Ia.—The Electric Light Company of Panora, Ia., at a recent meeting elected the following officers: President, Dr. C. M. Drumeier; vice-president, M. M. Reynolds; secretary, John M. Galbreath; treasurer, George M. Reynolds.

The Willamette Falls Electric Light Company, of Portland, Ore., has elected the following directors: C. H. Canfield, George Good, W. K. Smith, J. C. Moreland, W. M. Ladd, P. F. Morey, L. L. Hawkins, George Harding and C. D. McLaine.

Mechanicsville, N. Y.—The Fiberite Company, recently incorporated with a capital of $50,000, has purchased the water power and lands on Tenedaho Creek, and proposes to erect a large factory for the manufacture of electric light and street railway supplies.

The Brush Electric Light Company, of Rochester, N. Y., at its annual meeting chose the following directors: George W. Archer, George C. Buell, Hon. Frederic Cook, H. H. Craig, Jacob Gerling, John W. Martin, A. Erickson Perkins, E. M. Upton and V. F. Whitmore.

The Royal Electric Company, of Montreal, Canada, has nearly completed its new building. The building is 200 × 400 feet, and is four stories high. Three engines of 400, 500 and 700 h. p. have already been installed. The total cost will be between $175,000 and $200,000. The company now has three stations in the city furnishing 20,000 incandescent lights, 1,000 1,200-c. p. arc lights for public lighting and 500 private arc lights.

Providence, R. I.—The Inter-State Street Railroad Company has secured on private terms a controlling interest in the North Attleboro Steam and Electric Company and the North Attleboro & Wrentham Street Railway Company. The North Attleboro Steam and Electric Company supplies the lighting for North Attleboro, East Attleboro and Wrentham. It also furnishes lights for stores and private residences and the power used.

The New England Telephone Employes' Mutual Benefit Association has adopted a new constitution and by-laws, and elected the following officers: President, George H. Dresser; vice-president, E. W. Merrill; secretary, H. C. McCoy; treasurer, J. A. McCoy; directors, F. C. Locke, W. P. Whitney, George Cameron, O. W. Durgin, G. P. Pierce, P. H. Dacey, Charles Oliver, H. A. McCoy and F. T. Crockett.

The Worcester & Millbury Electric Railway Company has organized with the following officers: Directors—Samuel Winslow, president; T. M. Rogers, C. D. Morse, L. L. Whitney, E. I. Watson, T. T. Robinson, clerk and treasurer, and W. B. Ferguson. Contracts have been awarded to E. P. Shaw, of Newburyport, to build the road; George F. Chase, of Millbury, for the power station; Stewart Boiler Works, for the boilers; Jarvis Engineering Company, of Boston, to set up the boilers and piping; Armington & Sims, of Providence, for two 250-h. p. condensing engines; C. O. Richardson, for paving; Thomson Houston Company, of Lynn, for the generators; Graton & Knight, for the belting, and the Webb Construction Company for the paving stones.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, June 27, 1892.

E. L. Kellogg & Co., of 25 Clinton place, New York, are looking for an experienced man to wire their new building of six stories and basement at 61 East Ninth street, New York.

Postal Telegraph's New Building.—Excavations are now being made at the corner of Broadway and Murray street for a 12-story $750,000 building, to be constructed by the Postal Telegraph Company. It is much similar in architectural design to the Western Union Building on Broadway and Dey street. It will be used as the Eastern headquarters of the company.

The Lundell Dynamo, which has been undergoing a series of tests at the General Electric Company's works at Schenectady, is reported to give some very flattering results. This is an eight-pole machine, with interior and exterior poles. It was originally shunt wound, but has now been compounded and is said to regulate perfectly. The dynamo is intended to generate 400 ampères and 125 volts at a speed of 220.

A Blaze in the Edison Building.—On the morning of June 21 fire broke out from some cause as yet unknown, on the seventh floor of the Edison Building on Broad street. The whole of this story facing on New street was ruined, including the offices of the president, first and second vice-presidents and treasurer. The fire penetrated up through to the eighth story, damaging several rooms in the comptroller's office. A second fire occurred on the morning of June 24 from an equally mysterious cause. This time it originated on the eighth floor and was confined to one room Although the damage to the building was very much less than in the first fire, the real loss to the company is probably much greater, as a great many valuable papers, contracts and business letters were destroyed which it will be difficult, if not impossible, to replace.

L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 25, 1892.

Boston Braid Manufacturing Company reports that it has been kept very busy filling orders. It contemplates moving its factory.

The Laminar Fibre Goods Company, Boston, Mass., reports a very good sale for the past month of their different lines of manufacture.

Perry & Demerit, Montpelier, Vt., has recently issued a new catalogue, giving a full description of its L. P. & D. system of driving dynamos.

Mr. Albert E. Plowman, representing Porter Bros. & Co., of New York, was a recent visitor at this office. He reports business through this section for their insulating material very good.

The W. S. Hill Electric Company has moved its office from 54 Devonshire street to its factory, 133 Oliver street. It is introducing its new 15 ampère switch, which is claimed to be one of the most serviceable made for small motor service.

B. F. Sturtevant Company, Boston, now that the warm weather has come, is being rushed with orders for its blower and motor combination. It is also finding a good demand for its new design of engine which it is offering for sale.

The Bradbury-Stone Storage Battery Company, of Lowell, Mass., manufacturers of the ideal storage battery, finds the demand for its battery steadily increasing. Besides being used for electric light and power purposes it is also extending its operations to phonographs, fan motors, sewing machines and physicians' outfits.

Burnham & Duggan Railway Appliance Company, manufacturers of the Duggan Street Railway chair, are doing a very fair business. It might be mentioned in regard to this chair that it has no bolts or rivets, and is quickly and securely applied. In a recent test by the United States government it sustained a load of 78,200 pounds.

I. P. Oliver, Lincoln street, Boston, Mass., Boston representative of the Colburn Electrical Manufacturing Company, of Fitchburg, reports the sale of its motors for the past week both for power and fan purposes as being very satisfactory and that its factory has orders for three months ahead. It has just published a new catalogue illustrating its different makes of motors.

W. R. W.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, June 25, 1892.

Mr. Henry B. Slater, general manager of the Cañon City Electric Light and Power Company, of Cañon City, Colo., is on an Eastern trip after supplies.

Col. J. G. Metzger, of Minneapolis, of the Northwest Thomson-Houston Company, was married on June 16 to Miss Edith Mullan, daughter of Mr. S. E Mullan, of Washington, D. C.

Mr. Lafayette Cole, formerly traveling representative for Holmes, Booth & Haydens, has severed his connection with that company, and located permanently in San Francisco, where he will enter business for himself, with offices in the Crocker building. He has accepted the agency from the Railway Equipment Company, and has also perfected arrangements to represent Wallace & Sons and several other companies in the far West. Mr. Cole is an indomitable worker, is well known in the business, and his success in his new departure is the best wish of his many friends.

The Northwest Electric Fixture Manufacturing Company has opened a completely equipped factory at 16 and 18 South Franklin street, Chicago, for the manufacture of electric brackets, fixtures, etc. The officers of the company are Mr. Clas. Laubmayer, president; Bernard F. Webber, of B. F. Webber & Company, real estate dealers, vice-president, and J. P. Holmes, secretary and manager. Mr. Holmes was formerly connected with the firm of W. S. Bleckert & Company, and is thoroughly versed in the requirements of the trade, and able to promptly handle a large amount of business.

Mr. J. C. Duncan, receiver of the Knoxville (Tenn.) Street Railroad Company, for several years has had charge of the electric lighting and street railway interests of that city, and has succeeded by careful management in bringing up the properties which he represented to a well paying basis. Mr. Duncan, until September, 1889, was manager of the Western Union Telegraph Office in Knoxville, which position he had held for 25 years. He effected a consolidation of the electric light companies of Knoxville under one management, and on March 4 last was appointed by the court receiver of the local street railway. He has been unusually successful in his management of the business affairs of both the electric lighting and street railway business, and has made extensive improvements in the service of each.

F. DE L.

Inquiries from Correspondents.

Queries to be inserted in this column must be of general electrical interest, and must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. No notice will be taken of questions which involve nothing more than can be found in elementary treatises on the subject. All correspondence should be as brief as is consistent with clearness. Readers are invited to send discussions and answers to these questions, which will be inserted in the column below.

[120.] How is a chloride of silver dry battery made. R. R.

[121.] How is the frictional-pressure caused by magnetic attraction overcome in the Edison generator, which has a cast iron bearing spirally grooved to within one-half inch of each end, and the groove filled with babbitt metal. C. F. R.

News of the Week.

THE TELEPHONE.

Burlington, Vt.—The telephone line from Burlington to Addison, via Vergennes, has been completed.

Manchester, N. H.—The project of a telephone line across the country to Gilmanton Iron Works via Barnstead Parade and Center Barnstead is being seriously agitated.

The Sunset Telephone Company, of Oakland, Cal., is about to put its wires underground in the central part of the city. The estimated cost is $40,000. The company is also to erect a new building for its exchange.

Montreal, Canada.—At a large meeting of business men for the purpose of organizing a new telephone company, provisional directors were elected and steps were taken to complete the organization. It was decided to call the company the Merchants' Telephone Company, with a capital stock of $500,000, in shares of $25 each. It was also decided that the rates for telephones should not be over $25 per annum.

Washington, D. C.—By an act of 1890 the Chesapeake & Potomac Telephone Company were permitted to lay twenty miles of underground wire. By an act of March, 1891, the Commissioners were directed to prevent the construction of more than five miles sub-wires for telephone of service until April 1 last, unless Congress should first pass some general law on the subject of underground conduits, based upon the report of the electrical inspector. Congress has not passed any such law, and the telephone company contends that limitation of five miles imposed by this law has expired both in spirit and in fact, and that their permit is thereby revived. The matter came up before the Commissioners and was referred to the District Attorney for an opinion.

THE ELECTRIC LIGHT.

Orville, O., has its electric lights in operation.

Madison, Neb., is to have an electric light plant soon.

Assumption, Ill., is thinking of having electric lights.

Oxford, Ala., is preparing to light the city by electricity.

Worthington, Minn., will soon be lighted by electricity.

Sheldon, Ia.—Work on the electric light plant will begin soon.

Flemingsburg, Ky., is negotiating for an electric light plant.

Boone, Ia.—A $25,000 electric light is to be installed in the near future.

Covington, Ind., has contracted for water works and the electric light.

Gonzales, Tex.—An electric light plant will be established by T. S. Walker.

Edgard, Neb.—A new electric light power house is to be buil at Plattsmouth.

Ashtabula, O., has settled the lighting problem by buying its own electric plant.

Florence, Ga.—The electric light plant has been placed in the hands of a receiver.

Orrville, O.—The electric light plant has been started and is running successfully.

Highland Falls, N. Y.—There is a movement on foot to light the town by electricity.

Quincy, Mass.—Frank A. Bates is erecting a factory to be lighted by electric lights.

Rockford, Ind.—The electric light and water works plants have been destroyed by fire.

Cumberland, R. I.—The citizens are agitating the question of electric lights for their town.

Petersburg, Pa.—The City Council has unanimously decided to do its own electric lighting.

Titusville, Pa.—The electric light works were badly damaged by the flood and fire of June 5.

Columbia Borough Councils has closed a contract for street lighting for the ensuing year for $3,740.

Georgetown, S. C.—The Town Council is considering the advisability of lighting the town by electricity.

Lacon, Ill.—The electric lights have been turned on for the first time and everything is running smoothly.

La Salle, Ill.—Mayor Mathison has bought the electric light plant for $12,000 and sold it to the city for $1.00.

Denver, Colo.—The Consumers' Electric Light Company will commence the erection of a plant immediately.

Uxbridge, Mass.—The Uxbridge and North Uxbridge Electric Light Company has put in a new arc light dynamo.

Providence, R. I.—An addition to the plant of the Porter-Leavitt Electric Motor Company will soon be made.

Redwood Falls, Minn.—An electric company with ample capital is being organized. The plant will be let to the city.

Jamestown, Md.—Sealed proposals will be received until July 7 for establishing and operating an electric light plant.

Cameron, Tex.—Crawford & McLeod are considering the question of putting in an electric light plant at their oil mill.

Rochester, N. Y.—The Federal Building is to be lighted by electricity as soon as the necessary arrangements can be made.

Pocatello, Ind.—The Pocatello Electric Light Company has ordered two 1,000 arc light alternating machines, and will rewire the town.

Chester, Pa.—The directors of the Chester & Media Electric Railroad have awarded the contract for erection of the power house to J. Harry Slawter.

Bedford, Ind.—The Bedford Electric Light Company has changed its order from two 750-light machines to two 1,000-light alternating dynamos.

Florence, Ala.—The electric light plant has been put into the hands of a receiver on an order issued by Judge Simpson on complaint of the land company.

Cincinnati, O.—A new electric light company is to be started by Cincinnati capitalists in Louisville, Ky., in which Rudolph Klybolte & Co. are the prime movers.

Amityville, N. Y.—John E. Ireland and J. C. Mills, of Patchogue, are negotiating with E. P. Hampsom & Co. for engines and boilers and with the Westinghouse Electric company for dynamos to establish an electric light plant at Amityville.

Far Rockaway, N. Y.—The Citizens' Electric Light Company's plant, which started up on June 1, is running successfully. The equipment consists of two Armington & Sims engines, two 500-light Thomson-Houston alternating incandescent machines, and one 50-light 1,200-c. p. arc light Thomson-Houston machine.

Whitman, Mass.—The town of Whitman is soon to introduce a bill into the Legislature for permission to take the rolling mill water privilege in East Bridgewater and to erect an electric light station for furnishing light for the town. The town also binds itself to furnish East Bridgewater with electric lights at cost.

Whitehaven, Pa., claims to have the cheapest illumination of any town in the State. The streets are lighted by 2 000-c. p. lamps at a total cost of less than $600 per year, and the private residences are illuminated at a cost of 20c. per month for each 16-c. p. lamp. The borough owns its own plant, and gets its power from the Lehigh River.

Portland, Me.—General Manager Tucker, of the Maine Central Railroad, says the necessary amount of money for placing the proposed powerful electric search light on the top of Mount Washington has been subscribed. The light will be the highest and strongest

in the world, and will be seen from Maine, Massachusetts, New Hampshire, Vermont, New York and Canada.

Toronto Junction, Can.—Mr. Barr, manager of the construction company which is building the city and suburban electric street railway, proposes to erect a large power house capable of generating 10,000 h. p. and to supply the factories in this vicinity with power. As the town is very much in need of incandescent lights for interior lighting, it is not improbable that the company will make a bid for a franchise.

Philadelphia, Pa.—The bill authorizing the Edison Electric Light Company to lay conduits in the district bounded by South and Callowhill streets and the Delaware and Schuylkill rivers has been defeated in the Council by a vote of 21 to 5. The bill provided that the Edison company should spend at least $25,000 a year for a period of ten years, and that the conduits constructed for the use of the city should become at once the absolute property of the city.

Bayonne, N. J.—Progress toward granting an electric light franchise is being made. The mayor's veto of a resolution to introduce an ordinance for the Bayonne Electric Light Company has been overridden. The mayor states that he is in favor of a police and fire alarm telegraph system which the company offers as a bonus. There is a prospect of having another gas company to compete with. The only public lighting company, the Bayonne Gas Light and Fuel Company, is seeking legalization.

THE ELECTRIC RAILWAY.

Racine, Wis.—The Belle City Street Railway Company will erect a large power house on Main street.

The Oshkosh (Wis.) Street Railway Company is considering the matter of changing their motive power to electricity.

Richmond, Va.—It is rumored that the Richmond & Seven Pines Railroad is soon to pass into the hands of the Richmond Railway and Electric Company.

Canandaigua, N. Y.—Mr. C. J. Purdy, of the Canandaigua Electric Light Company, expects to equip the Canandaigua Street Railway with electricity in the near future.

Medford, Mass.—A meeting has been held to consider the petition from the West End Company for a franchise for running its cars through the town by the trolley system.

Fall River, Mass.—The Fall River *Globe* states that the owners of the rights to an electric freight railway are considering the advisability of erecting their plant at an early date.

Beverly, Mass.—It is rumored that obstructions to the electric franchise to the Naumkeag road by the selectmen have been removed and it is expected a permit will soon be granted.

The Vigo Real Estate Company has made final arrangements for the building of an electric railway to Highland Place, and in less than 60 days cars are expected to be running.

Dixon, Pa.—The Blakeley & Dixon Traction Street Railway Company has been incorporated with a capital of $26,000, and will construct a line to connect Scranton, Blakeley and Archibald.

Syracuse, N. Y.—At a meeting at Liverpool, of those interested in the proposed electric railroad from that town to Syracuse, committees were appointed to canvass for subscriptions for stock.

Worcester, Mass.—The Consolidated Street Railway Company has petitioned for a franchise to locate its tracks in Providence street and use electricity as a motive power on several of its lines.

Youngstown, O.—The Thomson-Houston company have been awarded the contract of building the electric railway from Mineral Ridge to Niles for $46,455. The former town will own and operate the road.

Brooklyn, N. Y.—Permits have been issued to William Richardson to erect trolley posts on Atlantic avenue, Washington avenue, Fifteenth street and Ninth avenue. The line is expected to be in operation by September next.

Philadelphia, Pa.—The Fairbill Railroad Company, capital $100,000, proposes to run from a point on the connecting railway between Filmore street and Hart's Lane in the Thirty-fourth ward to Camden street, a distance of one mile.

Port Richmond, N. Y.—The Railroad Commissioners have approved the application of the Port Richmond & Prohibition Park Electric Railway Company for permission to use the overhead single trolley electric system as motive power.

Watertown, Mass.—The selectmen have received a petition from the Newton Street Railway for the right to locate its tracks on Main street from the Waltham line to the tracks of the West End Street Railway Company. A hearing will be given on July 11.

Pittsburgh, Pa.—The Second Avenue Electric Street Railway Company has purchased a controlling interest in the Braddock & Turtle Creek Electric Street Railway. It is said the consideration approximated $70,000. The Second avenue line will extend its system to Braddock.

St. Louis, Mo.—The largest contract that has ever been made for street railroad work in St. Louis has just been closed. It involves the expenditure of $2,000,000. Completion of the contract will connect the Northern, Central, Union, Cass avenue and Citizens' street railroads into a single electric system. St. Louis will then have rapid transit on all its street car lines.

Long Island City, L. I.—Mayor Gleason, of Long Island City, has applied to the railway commissioners of the towns of Flushing and Newtown for a franchise to lay tracks for the purpose of operting an electric car route, which he proposes to run from the Thirty-fourth street ferry along Jackson avenue to and through the village of Flushing. The commissioners are considering the matter.

Whitman, Mass.—An important hearing in regard to an electric road from Weymouth, through Hanover, Rockland and the Abingtons to Whitman, was held June 20. The franchises have been promised in the other towns, and this meeting was a deciding one, as it determined in a measure the route of the road, whether through Abington or Whitman to Brockton. At the conclusion of the hearing a vote was taken upon the question, and it was unanimously voted to authorize the selectmen to grant the franchise with reasonable conditions.

Baltimore, Md.—The Lake Roland Elevated Railway Company has awarded the contract for the elevated structure on North street, between Lexington and Chase streets, to the Pennsylvania Steel Company. The elevated structure will be double tracked for 4,000 feet, and with the double track viaduct 400 feet long over the Baltimore and Lehigh Railroad Company's tracks at Stony Run, the contract for which was also given to the Pennsylvania Steel Company, there will be nearly two miles of single track elevated roadway. There being no grade crossings on the elevated structures, they will be built so that a speed of twelve or fifteen miles an hour can be maintained. Elevated stations will be erected at Madison, Centre, Franklin and Pleasant streets. The central station will be at the southern end of the structure in front of the central police station. The contract for the electric equipment has been awarded to the General Electric Company. The motors have arrived and the cars have been purchased. The cars will be twenty-four feet long and will be manufactured by the Pullman Company and will have paper wheels. Work is also progressing rapidly on the Central Electric Railway and it is thought that the tracks will be finished by July 20, the contracted time. The North avenue line will soon be completed and work on the Linden avenue road is soon to commence. It is reported that the Union Company intend to equip its white line with electricity immediately. Including both electric and cable roads, there is more railway equipment and construction work going on in Baltimore at present than in any city in the country.

LEGAL NOTES.

The Electrical Accumulator and Lighting Company, of Michigan, has obtained judgment against the Electrical Accumulating Company, of Chicago, for $26,116 for breach of contract.

North Attleboro, Mass.—The town recently voted to establish an electric light plant and now the Steam and Electric Company has entered a claim against it for $25,000, under the existing law that when a town votes to establish an electric light plant it must purchase any that have existed within its limits.

PERSONALS.

Mr. Nelson W. Perry has resigned his position as editor of *Electricity*.

Mr. E. E. Keller has just been appointed to superintend the Westinghouse Electric Company's lighting installation at the World's Fair.

Prof. F. B. Crocker sailed for Europe on Saturday, June 18. He will be gone about three months, and will visit electrical plants of special interest in Germany and Switzerland.

Mr. Samuel Insull was tendered a complimentary dinner on Friday night of last week by his friends and associates in New York City. Mr Insull is about to leave for Chicago to take up his work as president of the Chicago Edison Illuminating Company.

Mr. D. H. Ogden has been made business manager of the *Western Electrician*, in place of Congressman Allan C Durborow, resigned. Mr. Ogden was formerly general manager of the Iowa Telephone and Telegraph Company, and has been identified with other lines of electrical work for many years. He has been associated with the *Western Electrician* for about two years.

Mr. George Westinghouse had a narrow escape in the collision on the Pennsylvania Railroad last Saturday. He was traveling with his family in his private car, which was attached to the rear of the first section of one of the Pennsylvania expresses. The second section collided with the first and almost entirely demolished the two passenger coaches in front of Mr. Westinghouse's private car. Although 11 people were killed in the wreck, and a score or more injured, only one in the Westinghouse car received any injuries and his were slight ones.

MISCELLANEOUS NOTES.

The Order of Railway Telegraphers will hold its next annual convention at Toronto in the latter part of May, 1893.

Mine No. 7, Rock Springs, Wyo., is now receiving a $25,000 electric plant, to be operated over a distance of one and three-quarters miles.

The Richmond (Va.) Plant has just put in a large new press which is driven by an electric motor. The offices are also lighted by electricity.

Rome, N. Y.—The Electric Light Works is about to put in power circuits for the purpose of furnishing power to run light machinery. Patrons will be furnished with as high as 5 h. p.

The Annual Clam Bake of the American Electrical Works, Providence, R. I., will be held this year at an earlier date than usual. Mr Phillips informs us that the time fixed for the feast this year is Saturday, July 23.

The Corcoran Scientific School, one of the departments of the Columbian University at Washington, D. C., has issued a circular offering a special course in electrical engineering. The department of physics is in charge of Prof. E. P. Lewis.

Amateur Electricians' Union.—Mr. G. C. Minor, of the Chesapeake & Potomac Telephone Company, Baltimore, Md., requests that any young man under 20 years of age who would like to assist in forming an Amateur Electricians' Union should correspond with him.

The Postal Telegraph Company has finally purchased the telegraph line between Chicago and Milwaukee, which for five years it has operated under contract with certain Chicago and New York capitalists who built the line. It has paid hitherto 100 per cent. in annual dividends to them.

Entrance examinations for admission to the classes of the Massachusetts Institute of Technology will be held on June 30 and July 1, and the second series on Sept. 22 and 23, at the following places: Boston, New York, Philadelphia, Chicago, St. Louis, Cincinnati, San Francisco, Washington, Detroit, St. Paul, Pittsburgh, Montreal, Denver, Albany, Poughkeepsie, Easthampton, Mass., and Exeter, Mass,

Steered by Electricity.—The double-turreted monitor Miantonomoh was steered by electricity on her sea-going trip. This is the first application of electricity to this purpose on board an American ship. The monitor is the most difficult kind of a craft to steer, and if this attempt proves successful, as it gives every evidence of doing, it will be an easy matter to apply the device to other classes of vessels.

Industrial and Trade Notes.

The Central Electric Company is selling large quantities of incandescent switches and keyless sockets of approved manufacture and keeps a very large stock of these on hand.

The Buckeye Electric Company, of Cleveland, is very well satisfied with the success of its new double coil filament 32 c. p. lamp, and reports that orders are coming in fast for Buckeye lamps.

E. P. Mampson & Co., No. 36 Cortlandt street, New York, furnished the engines, boilers and pumps for the Far Rockaway electric light plant and J. C. Mills, of the Patchogue Electric Light Company, acted as consulting engineer.

The Sunbeam Incandescent Lamp Company, of Chicago, is meeting with good success with its special railway lamp. The filament is so tough that it does not require a steadying hook, and it is said to give excellent satisfaction.

The Waterbury Brass Company, of Waterbury, Conn., is putting up its new wire mill, which will be of iron, designed and furnished by the Berlin Iron Bridge Company, of East Berlin, Conn. The rolling mill will be 100 feet wide by 160 feet long, with a wing (to be used for drawing wire) 40 feet wide by 230 feet long.

The Central Electric Company reports having sold during the past week 150,000 feet of assorted sizes of interior conduit, with elbows, junction boxes and couplings. The Central Electric Company is the general Western agent for the Interior Conduit and Insulation Company, and carries a large stock at all times.

John A. Seely, general manager of the Complete Electric Construction Company, 10 Cortlandt street, New York, has just secured the contract from the city of Martin's Ferry, O., for an arc and incandescent plant. For the excellent work done in the installation of the 400-arc light plant at Wheeling, W. Va., Mr. Seely recently received a vote of thanks.

The Knapp Electrical and Novelty Company, of 34 Warren street, New York City, is sending out a handsome little circular containing an illustration and brief description of its small fan motors and fan outfits. These are put up in two different styles, one of which is guaranteed to run 125 hours and the other 100 hours without recharging the battery.

Messrs. Woodhouse & Rawson United Limited inform us that they recently opened a branch office, show room and stores at 16 Fleet street, Dublin their former agencies at Belfast and Cork being given up and the whole of their Irish business concentrated in Dublin, under the management of Mr. Arthur H. M. Francis, to whom all communications should be addressed.

The Manhattan Electrical Supply Company, incorporated under the laws of the State of New Jersey, with an authorized capital full paid of $20,000, has purchased the good will, business, patents, trade marks and stock of the Manhattan Electrical Supply Company, incorporated under the New York State laws, and will continue in the electrical supply business at 36 Cortlandt street, New York.

Mr. William N. Marcus, of the firm of Fuller & Marcus, of Philadelphia, is the inventor of an attachment for telephones known as the auxiliary mouth piece. This appliance is said to be very efficient and to be meeting with considerable favor where it has been tried. Mr. W. C. Tripler, Jr., of 218 North Second street, Philadelphia, Pa., has charge of the business of manufacturing this apparatus.

The Ball Electric Light Company, 404 West Twenty-seventh street, New York, has recently issued a very attractive little catalogue setting forth the merits of this well-known system. The dynamo, the arc lamp, the reciprocating carbon all-night lamp, the long distance series incandescent system and the improved series system of this company are all described in a clear, practical manner. A large number of very interesting testimonials furnish some very readable matter.

The Sperry Electric Mining Machine Company, of Chicago, is in receipt of orders from several foreign countries for its standard fuse wire, and this last week sent a quantity to Japan. The Sperry company believes that this export trade, as well as the large and rapidly growing domestic trade, is due entirely to the careful preparation and systematic drawing of the wire, which insures perfect accuracy. The various sizes are wound on light metal spools and packed in boxes holding one pound each.

The Okonite Company is to be congratulated upon the continuous success of its high grade wire, the sales for the past week amounting to upward of one million feet, through the hands of the Central Electric Company, the general Western agent. One single order amounted to 225,000 feet, besides a constantly increasing demand among the regular customers. The large stock held by the Contral Company of all sizes of wires, coupled with the unexcelled quality of the product, is perhaps some reason for the favor with which the wire is regarded.

Gould & Eberhardt's Machine Tools.—The recent orders received and shipments made of the Eberhardt's improved automatic tools for electrical and other work demonstrates very clearly that there is an increasing demand for good, substantial tools which will stand the severe test of use in shops which are run to produce dividends on the money invested. Those who put their money in new enterprises should see to it that their plants are fitted up with tools of this character, which although requiring a greater outlay in the start will pay many times in the dividend-earning capacity of the plant.

A Builders' and Contractors' Guide.—Among new publications is "The Architects' and Builders' Guide and Contractors' Reference Directory," now in its second edition, and issued by S. E. Hendricks & Co., New York. It seems to be very complete, and the publishers claim that it includes every manufacturer, dealer, contractor and others interested in everything employed in construction work, from the raw material to the manufactured article and from the producer to the consumer. All the architects of the United States, Canada, Cuba and Mexico are grouped in this cred itable work, which further contains supply men of all kinds.

The Electric Appliance Company is just at present rejoicing over the completion of its catalogue and is very busy distributing several thousand copies. It certainly has reason to be proud of its efforts, as it has issued a very complete and attractive volume. It has been its aim from the start to produce a catologue that would contain the greatest amount of information in the smallest possible space. How well it has succeeded is shown by the fact that in a catalogue five inches by eight inches, with 200 pages, they have included practically everything in the electrical supply line, giving a complete list of supplies in the following departments of the business: Electric light and power supplies, electric railway supplies, electrical house goods, fire alarm supplies, telephone supplies, telegraph supplies, physicians' electrical supplies and electrical toys and novelties.

Quick Work by a Bulk Electric Contractor.—A very handsome new church was recently presented to the parish of White Plains, and the architect, Mr. T. H. Poole, of New York City, contracted with one of the large electrical manufacturing companies to put in wiring and fixtures for electric lights, and made arrangements with the local lighting company to install a special dynamo and supply current. It was intended to use the lighting plant at the consecration exercises, but as that day drew near it was evident that neither company would be ready. The day before the exercises the architect concluded that he must have electric lights if it were at all possible, and so he called upon H. Ward Leonard & Co., New York City, at 4:30 in the afternoon and asked if it would be possible to install the plant and have it running in time for the exercises, which would come off at 10:30 the next morning. It was necessary to secure, deliver at White Plains, and install the dynamo, complete the wiring of the church, run the line to the central station plant, alter the speed of the engine, supply belting, foundation, etc. The contract was promptly accepted and at 10:15 the next morning the entire plant was operating perfectly.

Porcelain Supplies.—The manufacture of the various porcelain specialties found on the supply counter has grown to be an independent branch of business, requiring the highest form of skilled labor in its successful management. A perfectly equipped factory must have, in addition to its several big kilns and complete pottery, a thoroughly equipped machine shop fitted with the finest milling machines and lathes for making the steel dies requisite in forming the various styles of insulators required, as well as other special devices. A forge is needed, and a packing box factory will form an economical feature. All these are found in the ex-

tensive buidings of the Peru Porcelain Works, at Peru, Ind. Here the clay and other earths are brought to the "bin-room" in carload lots and dumped into the big bins; from thence they pass to the mixing and agitating room, where the plastic mass is formed, thence to the "stamping room," where it is pressed into a hundred different shapes by means of hydraulic or hand presses fitted with steel dies. These varied forms then pass to the inspecting room; thence to the "biscuit" kiln, and on to the "gloss room;" then to the assorting and packing room, where they are placed in suitable packages and loaded into cars that run to the doors. Among these specialties are porcelain blocks, switch bases, cut-outs, battery covers, insulators, etc.

A Card to the Steam-Using Public.—Mr. S. D. Brewer, of the Hussey Re-Heater System, 50 Broadway, New York, has sent us the following letter: It having been brought to my attention within a day or two that printed matter is being circulated wherein my name appears as general manager of the "Hussey Re-Heater and Steam Plant Improvement Company," I would state that I have not been connected with that company for over two years. For your further information I would advise you as follows: In 1883 Mr. Hussey patented two re-heaters for re-heating exhaust steam. These re-heaters were manufactured and sold by Mr. Donaldson and Mr. Hussey conjointly, afterward by Mr. Donaldson, and in 1884 by the Donaldson Heater Company, of which I was secretary. Within a few months I, individually, secured the exclusive right to manufacture and sell them. In 1888, on the strength of certain promises, I organized, with others, the "Hussey Re-Heater and Steam Plant Improvement Company," of which I was general manager. But after two years with that company I resigned as its general manager, at the same time withdrawing such interests as I had, and since then I have had no connection with it. I intended at the time to open an office for the continuation of my business, but while making the necessary arrangements I concluded to spend a short time in the electrical business, since I knew very little about electricity and realized that it was to play an important part in the steam business. I entered the Edison company, and only recently left it. How long my name has been used in the manner mentioned I do not know, but I wish, even perhaps at this late day, to state that I am not interested, either directly or indirectly, in any business except my own.

Engineering Enterprise in Japan.—The last mail from the Orient brings a very interesting account of the completion and successful operation of a great government work in Japan. Lake Biwa, having an area of 500 square miles, is located 7 miles from the City of Kioto and at an elevation of 143 feet. A navigable canal has been cut from this lake to Kioto, involving two miles of tunneling and an aqueduct of considerable length. At the eastern extremity of the city, to which point the canal has been brought, there is a sharp decline of 118 feet, from the base of which the canal is continued to the sea. This difference in level is overcome by inclined planeways 2,100 feet in length, on which boats are raised and lowered from one canal to another. These ways are operated by electric power furnished from a Pelton water wheel connected with a Sprague motor. The fall above named affords also a very valuable water power, a part of which has already been utilized for various mechanical purposes by means of electric transmission. The power station is located at the foot of the incline and consists of three 8 foot and two 6-foot Pelton wheels, aggregating about 600 h. p., which are supplied with water from the high level canal by three lines of 36 inch pipe 1,300 feet in length delivering water to the wheels under a head of about 100 feet. These wheels are as present operating three Edison dynamos of 80 kilowatts each, the power from which is distributed about the city within a radius of two miles, running rice mills, spinning mills, a watch factory and various other machinery. One Thomson-Houston alternating current dynamo of 2,000 volts supplies the city with 1,300 incandescent lights as well as many arc lights. The above works, involving an expenditure of $1,500,000, were planned by and executed under the direct supervision of Mr. S. Tenabe, an eminent Japanese engineer, and their operation is said to be a great success, both from a mechanical and financial point of view.

New Quarters of the Railway Equipment Company.—After much trying delay the Railway Equipment Company, successor to the Electric Merchandise Company, is ready to welcome its patrons to its elegant quarters in the Pullman Building, Chicago. The rooms have been in the hands of the decorator and finisher for several weeks, and everything possible has been done to make them beautiful and comfortable. The offices front upon Michigan avenue, and are on the ground floor. To the immediate left of the entrance is what might be called the visitors' parlor. The general manager's office is also in front and just back of the visitor's parlor. To the rear of the general manager's office is that of the secretary and treasurer, agreeably accessible to customers. Next in order upon the right is the bookkeeping department, with the necessary desks and files. Inclosed by the bookkeeping department is a neat space for the use of the stenographers. The purchasing agent occupies the rear of the main office on the left, where he is conveniently near the storerooms and shipping department. The same side of the office furnishes inclosed desk room for the salesmen and also space for a large showboard, where is exhibited all the various pieces used in electric railway construction. If one desires to see quantity rather than to examine the quality of the company's wares, a door at the farther end of the offices admits him to a storeroom, where bins and shelves filled with the many devices handled by the house line the walls. Much of the more bulky material is kept in the spacious storerooms in the basement. Moving into such commodious and pleasant quarters is the natural outcome of the growth of this company's business and a witness of its popularity with the trade. Three years ago, under another name, but with the same general manager, Mr. W. R. Mason, in charge, it started in a unique business—the handling of electric railway supplies exclusively, and since then has done a very heavy business. Less than a year ago its quarters were found insufficient and were doubled; again it became necessary to better its facilities. A great majority of the electric railways of this country are its regular customers. Irrespective of the energetic qualities of the company's officers, its prosperity is undoubtedly largely due to its honest intention to furnish the best possible quality of material to purchasers.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Burlington Route—New Service.—A through Pullman sleeping car, Chicago to San Francisco, is a feature of the Burlington's new service. This car leaves Chicago daily on the fast train at 1:00 P. M., and runs via Denver, Colorado Springs, Leadville, Glenwood Springs, Salt Lake City and Ogden, arriving in San Francisco at 11:45 A. M., less than four days *en route*.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

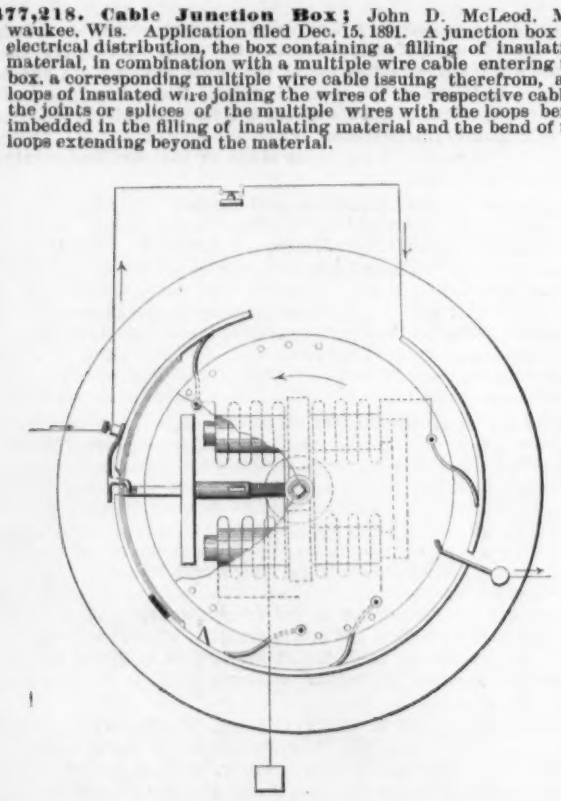
[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.

U. S. PATENTS ISSUED JUNE 21, 1892.

477,212. Means for Preventing Collisions on Railways; Heinrich George Held, Zwolle, Netherlands. Application filed Nov. 19, 1888. The combination of movable tongues, means for fixing them in one position or the other, connections whereby the fixing devices may be operated to change the direction of operations of the tongues, and a signaling apparatus on the train adapted to engage the tongues.

477,214. Electric Controlling Apparatus for Fire Alarms; George Knowles, Jr., Milwaukee, Wis. Application filed Dec. 3, 1889. The combination, with a main and a branch circuit supplied with current from the same source, of signal-transmitting mechanism and an electromagnet having its winding normally in connection with the main and branch circuits and arranged to control the signal-transmitting mechanism in its operation, and a shunt around the winding of the magnet, having sufficient resistance to force current through the branch when it is closed and both shunt and branch are in circuit. (See illustration.)

477,218. Cable Junction Box; John D. McLeod, Milwaukee, Wis. Application filed Dec. 15, 1891. A junction box for electrical distribution, the box containing a filling of insulating material, in combination with a multiple wire cable entering the box, a corresponding multiple wire cable issuing therefrom, and loops of insulated wire joining the wires of the respective cables, the joints or splices of the multiple wires with the loops being imbedded in the filling of insulating material and the bend of the loops extending beyond the material.



No. 477,214.—Electric Controlling Apparatus for Fire Alarms.

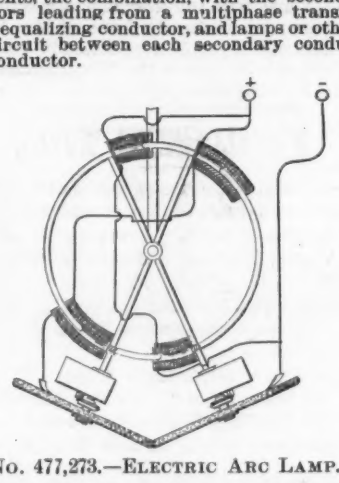
477,219. Carbon Rod Contact for Arc Lamps; Charles McNellis, Chicago, Ill. Application filed Jan. 26, 1892. A device for making contact with the carbon rod of an electric lamp, consisting of a contact brush of comb-shaped metal curved so as to enter the tube through which the carbon rod passes, said comb-shaped piece of metal having its teeth curved and having a flange adapted to rest upon the end of the tube, in combination with a cap adapted to be screwed on the end of the tube and to press on the flange of the contact brush, whereby the contact brush is detachably held in place in the tube.

477,221. Electric Arc Lamp; Lemon Parker, St. Louis, Mo. Application filed July 13, 1891. An electric-arc lamp having a clutch for gripping the carbon itself, consisting of two suitably perforated plates, one overlying and articulated to the other; electromagnetic devices for controlling one of the plates, and thereby the other plate, and adjustable stops between which said plates are adapted to play.

477,223. Means for Operating Ammeters and Other Electrical Apparatus; Herbert M. Pilkington and Roger S. White, Brooklyn, N. Y. Application filed Sept. 24, 1891. The combination, in an ammeter or similarly operated indicator, of a movable member, such as an index-hand, one or more armatures connected therewith, and several coils in separate line wires acting in conjunction on the armature or armatures.

477,247. Rheostat; George K. Cummings, Chicago, Ill. Application filed Dec. 11, 1891. In an electric regulator or rheostat, an electric conductor of high resistance imbedded in a block or plate of molded insulating material.

477,250. Distribution of Rotary Electric Currents; Alard Emile DuBois-Reymond, Berlin, Germany. Application filed April 30, 1891. In a system of distribution of multiphase electric currents, the combination, with the secondary distributing-conductors leading from a multiphase transformer, of an independent equalizing conductor, and lamps or other translating devices in circuit between each secondary conductor and the equalizing-conductor.



No. 477,273.—Electric Arc Lamp.

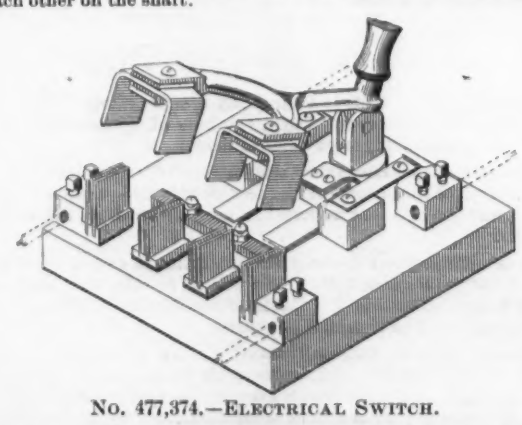
477,273. Electric Arc Lamp; Norman F. Rutherford, Bathurst, N. S. Wales. Application filed August 13, 1891. The combination with a pair of levers pivoted at their intersection, each carrying a carbon electrode, of two pairs of solenoids, one in the main circuit of the lamp and the other in the shunt circuit of the lamp, one of the levers carrying the main magnets and the cores of the shunt magnets and the other carrying the shunt magnets and the cores of the main magnets. (See illustration.)

477,301. Electric Jail; Perley Hale, Chicago, Ill., and Charles H. Sparks, St. Louis, Mo. Application filed Sept. 7, 1891. A cell having vertical and horizontal grate-bars forming a cell grating and provided with channels for the passage of insulated electrical conductors, a ceiling and floor composed of plates, insulated electric conductors interposed between the plates, an alarm mechanism, and suitable electric connections.

477,315. Thermostatic Circuit Closer; Walter H. Tapley, Chicago, Ill. Application filed Aug. 14, 1889. In a thermostat, the combination of the elastic strip or spring, two adjustable pointers, each mounted upon a separate circuit pivot, the pointers each carrying a contact point through which the current is transmitted by way of the contacting strip and the respective circuit pivot of the pointer, and a graduated scale at the swinging ends of the pointers.

477,374. Electrical Switch; Charles J. Klein, New York. Application filed May 28, 1891. An electric switch having electrodes supported at the free ends of two springs, a pair of electrodes adapted to contact therewith, a pivoted operating handle, and means located in the path of the free ends of the springs and adapted after they have been put under the street by the operating handle to cause the electrodes to be positively separated. (See illustration.)

477,383. Printing Telegraph; Charles J. Reed, Orange, N. J. Application filed May 27, 1891. A distributer for distributing electrical currents to independent circuits at a receiving station, consisting of a series of distributing plates united each to an independent conducting ring carried by the same shaft which carries the distributing plates, the rings being located adjacent to each other on the shaft.



No. 477,374.—Electrical Switch.

477,384. Printing Telegraph; Charles J. Reed, Orange, N. J. Application filed July 6, 1891. A pair of distributers joined by an electrical conductor, a series of key levers for each distributer, and a series of relays having local circuit connections through electromagnets operatively connected to the key levers of a typewriter at each end of the conductor, the local circuit connections including means for holding the local circuits closed for a short time after the main circuit is broken.

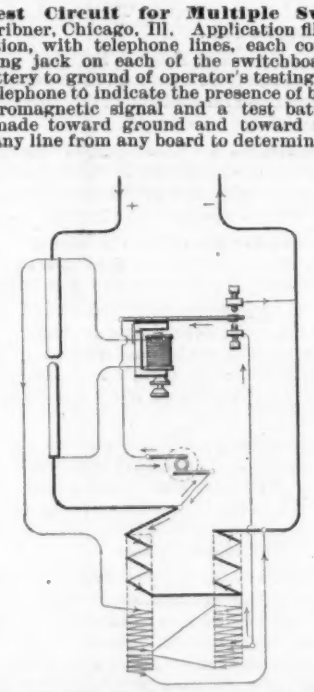
477,407. Incandescent Electric Lamp Socket; Jacob S. Gibbs, Hartford, Conn. Application filed Feb. 27, 1892. A lamp socket consisting of a shell with a single division of insulating material supporting binding posts for circuit wires and contacts for a lamp, one of said contacts being connected with a conductor bearing a sliding piece and key adapted to make or break connection between the sliding piece and a part of one binding post.

477,409. Electric Switch; Edwin T. Greenfield, New York. Application filed Dec. 16, 1891. A pair of snap-acting electrodes, in combination with a spring actuated arc interrupter or insulating material for intercepting an arc established between the electrodes.

477,427. Electric Arc Lamp; Frédéric Victor Macquaire, Paris, France. Application filed Aug. 13, 1890. In an electric arc lamp, the combination of an electromotor adapted to operate both the upper and lower carbon holders and an electro metric balance adapted to maintain absolutely constant the strength of intensity of the current, the electromotor having an exciting current formed by two separate conductors through each of the electromagnets traversed by the main current. (See illustration.)

477,483. Electric Motor; Frederick Yeiser, Tampa, Fla. Application filed Sept. 22, 1891. In an electric motor, a commutator comprising an annulus or band connected with the armature-helix, a spiral plate insulated from the band, and having its sections in different vertical planes and out of line longitudinally with each other along the armature shaft, the two sets of commutator brushes included in the circuit of the field magnets and adapted to be independently brought into contact with the commutator.

477,579. Test Circuit for Multiple Switchboards; Charles E. Scribner, Chicago, Ill. Application filed May 12, 1885. The combination, with telephone lines, each connected with a different spring jack on each of the switchboards, and thence through a battery to ground of operator's testing apparatus consisting of a telephone to indicate the presence of battery, together with an electromagnetic signal and a test battery, whereby a test may be made toward ground and toward the subscriber's station over any line from any board to determine whether a line is busy.



No. 477,427.—Electric Arc Lamp.

477,595. Electric Switch; Jesse L. Hinds, Syracuse, N. Y. Application filed July 23, 1891. In an electric switch, the combination of a supporting post, a spring plate having its central portion carried by the post and its arms extending in substantially the same direction, a pair of terminals on opposite sides of the free extremities, and a cam for forcing the extremities against the terminals.

477,612. Electric Switch; Eugene A. Snow, Syracuse, N. Y. Application filed July 23, 1891. In an electric switch, the combination, with a pair of terminals, of a pair of supports, a spring supported at its opposite extremities by the supports, and a cam for engaging the spring with the terminals, the cam being adapted to engage the central portion of the spring.

477,616. Electric Annunciator Drop; James C. Warner, Chicago, Ill. Application filed June 17, 1889. The combination with a coil or helix of a soft iron shield surrounding the same, the armature at the rear of the core of the helix, and the armature lever extending forward through a slot or opening in the plate, and a drop with which the lever is adapted to be engaged when the drop is lifted and to be disengaged therefrom when the armature is attracted.

477,628. Electric Heater; Charles E. Carpenter, Minneapolis, Minn. Application filed Nov. 29, 1890. In an electro-heating apparatus, the combination, with the iron core and primary coil wound thereon, the convolutions of the coil being insulated from the core and from each other, of a shell surrounding the coil and constituting the secondary element.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.